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A HOLLOW CONCRETE-STEEL DAM AT THERESA, N. Y.

By Ambursen & Sayles.*

Some time ago there were several articles in the Engineering News about concrete-steel gravity dams. Thinking it may be of interest, we present herewith a sectional drawing and some photographs of a dam that we have recently constructed for the firm of Snell & Makepeace, at Theresa, N. Y. The dam was designed by Mr. N. F. Ambursen, the senior member of our firm, and has been patented. The dam is built of concrete, reinforced with Thacher patent steel rods and expanded metal. It is 120 ft. long and 11 ft. in height and built upon solid rock.

The construction (see Figs. 1 and 3) consists (1) of a solid concrete toe; (2) of a series of solid concrete buttresses 12 ins. thick, spaced 6 ft. c. to c.; (3) then upon the inclined up-stream sides of the buttresses is laid 6 ins. of concrete, reinforced with Thacher steel rods and expanded metal. The concrete in the dam proper was 1 part Portland cement, 2 parts sand, and 4 parts broken limestone. In the toe and buttresses the mixture was 1 : 3 : 6. The buttresses were anchored to the rock with 1¼-in. iron pins, 36 ins. long. Where the surface of the rock was exceptionally rough the pins were omitted.

The cross-section, Fig. 1, shows the spacing of the rods and the position of the expanded metal. The crest is strengthened with a 6 × 8-in. concrete beam, reinforced with two ½-in. rods. The dam is so constructed that all the pressure comes within the base, and it is entirely a gravity dam under any head of water.

The forms for the concrete were shop-made and ready for use by the time the cofferdam was completed. They were made in sections and only required piecing out at the bottom to fit any unevenness of the bottom of the river bed. Forms for eight spans were made and were used over and over and are still in good condition. Fig. 2 shows the dam after the first section had been completed.

Several bids were received by the owners for timber and solid masonry dams. Our bid being but very little in excess of the cost of the timber construction, we were awarded the contract and completed the work to the entire satisfaction of Messrs. Snell & Makepeace, and we add to our own, also. The dam was built in 18 actual working days, with an average of ten men (three carpenters and seven laborers). The above includes the time and labor of removing the old timber dam and constructing cofferdams. The water was 4 to 5 ft. deep outside our cofferdams. The dam contains about 125 cu. yds. of concrete. The high water mark is 6 ft. above the crest of the dam. Fig. 4 shows the dam after completion, with water flowing over it.

For overflow dams of considerable height the back faces of the buttresses can be built to receive a covering similar to that on the front of the dam, and thus form a properly shaped spillway for the water. The formation of a vacuum is also easily prevented in this style of construction.

*Engineers and Contractors, Watertown, N. Y.

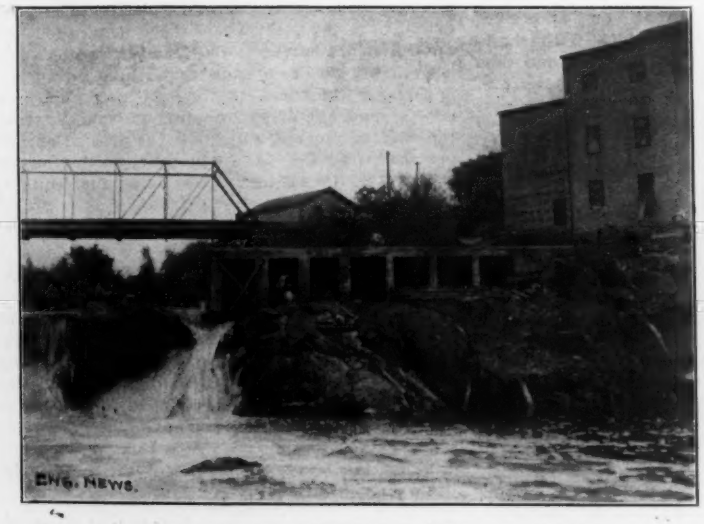

Fig. 2. From Below: First Section Completed.

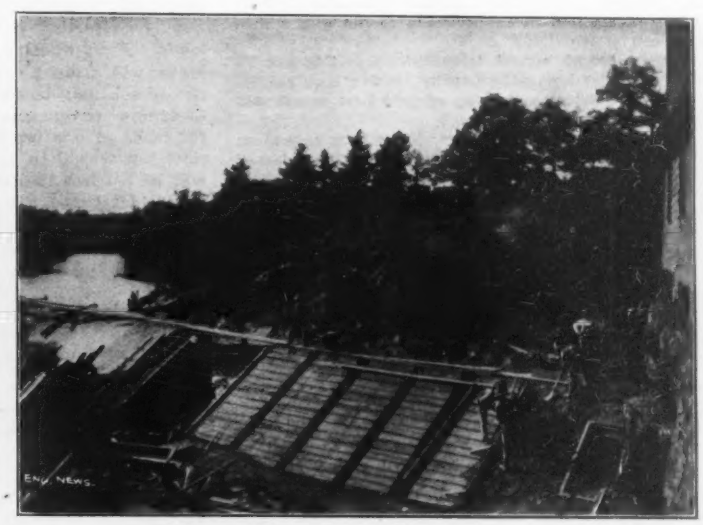

Fig. 3. From Above: Showing Forms, Rods and Expanded Metal.

CONCRETE-STEEL DAM UNDER CONSTRUCTION AT THERESA, N. Y.

THE FATIGUE OF CEMENT PRODUCTS.*

By J. L. Van Ornum, M. Am. Soc. C. E.†

Although the investigation has only begun, the writer believes that the importance of the subject makes it advisable to state the results of experiments (as far as obtained), made under his direction, to determine the behavior of certain Portland cement mixtures when subjected to repeated loads of a less intensity than would produce failure when once applied. Certain observed peculiarities in tests of concretes led to the conclusion that brittle engineering materials (such as stone, brick, mortars, concretes, etc.), of which cement mixtures are a fair type, possess the property of a progressive failure or "gradual fracture" which finally becomes complete under the repetition of a load well within the ultimate strength of the material. The analogy to the similar property of steel, proved by Bauschinger and Wöhler about 40 years ago, is evident.

The probability of this fact was indicated to the writer last December, when some peculiar results of an investigation made on concretes at Washington University could only be explained, apparently, on the hypothesis already mentioned. The time which has since elapsed has been too short for the extended investigation necessary to develop details, but results thus far obtained indicate plainly that this characteristic is true.

The experiments made were compressive tests upon neat Portland cement blocks (approximately 2-in. tubes), using a standard American brand, and crushed when four weeks old. The tests were made by Mr. Hans Schantl, of the civil engineering department, an expert experimenter. The ultimate strength was determined in the usual way, and similar blocks were subjected to certain percentages

*A paper read Oct. 21 before the American Society of Civil Engineers and published on p. 627 of "Proceedings," for August.

†Professor of Civil Engineering, Washington University, St. Louis, Mo.

of the ultimate strength, varying from 95 to 55% of the same, the load in each case being applied and removed repeatedly until failure occurred. In all, ninety-two blocks were tested, and the average results are indicated graphically in the accompanying diagram.

In general, the figure indicates that failure occurs under repeated loadings of much less intensity than that necessary to cause failure when once applied (the latter being the test always relied upon to judge of the strength of such a material), and that the number of repetitions necessary to cause rupture is greater for the smaller loads,

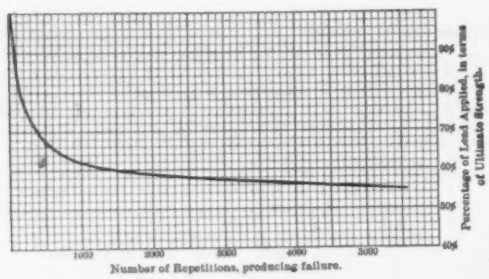

Diagram Illustrating Effect of Repeated Stresses Upon Compressive Strength of Portland Cement.

as would be expected. This curve should be considered characteristic, and not precise; it does not indicate necessarily the exact relation between the number of repetitions and the corresponding intensity of load, but rather typifies the general law of "fatigue" as outlined above. It should also be said that while time has not yet permitted similar systematic tests on concrete, yet 18 repetition tests on 7-in. cubes indicate by their behavior that the same general law of gradual failure applies equally to concretes.

It is to be hoped that this investigation may be extended as rapidly as circumstances will allow. In determining the proper factor of safety to use, for concretes under various conditions of design, such facts would be especially pertinent. Concretes vary so widely in character and quality of materials, proportions of ingredients, and in characteristics depending upon age, conditions of loading, whether or not reinforcing metal is introduced, etc., that much time and labor will be necessary to establish the law of "fatigue" under the various conditions existing. Especial care is also necessary because of the difficulties inherent in securing definite results with cement products.

If a number of research laboratories should become interested in developing the actually existing laws and relations indicated, the securing of the useful results will be expedited.

A certain portion of this research has been undertaken by Washington University, and the writer has planned a series of experiments which will continue throughout the year in its testing laboratory. It is the intention to make public, the results, as definite facts and the principles of behavior of these materials under repeated loads are developed.

THE DISCOVERY OF TIN IN SOUTH AFRICA is reported in "The British South African Export Gazette" of Sept. 4. The tin ore has been found on the eastern border of the Transvaal, on the edge of the high South African plateau, where the underlying formation is granite. Overlying this granite are the remnants of schistose rocks, and the tin ore is found on the contact of the schist and granite, three lodes having been discovered that average 3.5% of tin.

SOME OBSERVATIONS ON STREET PAVEMENTS.*

By S. Whinery, M. Am. Soc. C. E.

(Concluded from p. 381.)

VII.

Pavement Foundations.

In the matter of foundations for pavements there exists the same absence of scientific treatment as in other branches of the subject. That a foundation is necessary is assumed as a matter of course; but there is a variety of opinion regarding the character and strength of foundation necessary for the several kinds of pavement in common use, which seem to be based on offhand judgment, or at the most on empirical considerations. It is not possible in a brief sketch such as this to treat the subject properly, but attention may be called to some of the leading questions involved.

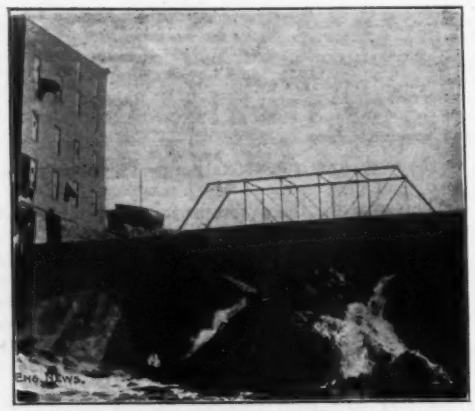

Fig. 4. Water Flowing Over Concrete-Steel Dam at Theresa, N. Y.

As in other engineering construction, the structure must be designed for maximum loads, though not necessarily for abnormal or excessive loads. Four-wheeled vehicles which with their loads will seldom exceed four tons, or one ton per wheel, may be safely assumed as a basis for designing pavement foundations. Trucks used for loads of one ton per wheel will usually have tires not less than 4½ ins. wide and the wheels will be not less than 3 ft. in diameter. The area of contact between such wheels and a pavement whose surface is a true plane will not often exceed 1 in. wide and on hard and unyielding materials, like brick and stone, will not exceed ½-in. Experiments were made by myself a few years since to determine the area of contact between a truck wheel and the surface of a good asphalt pavement. The truck wheel was 36 ins. diameter with 4½-in. tire, having a flat surface about 4 ins. wide, carrying a load of about one ton. The wheel was jacked up and a sheet of carbon paper between two sheets of white paper was placed underneath. When the wheel was let down upon this paper the surface of contact between the wheel and the pavement was printed on the white paper and its area and peculiarities could be observed. It was found that this area was bounded by irregular lines, its width seldom reaching more than 1 in. and its length being seldom equal to the width of the tire. This was due not only to slight departures of the pavement surface from a true plane, but to irregularities in the surface of the pavement or of the tire, or the inclination of the latter to the surface of the pavement. The conclusion reached was that the area of actual contact did not average more than two-thirds the width of the tire multiplied by 1 in. Thus, with a tire having a flat face 4 ins. wide the actual area of contact between the wheel and the surface of a good asphalt pavement seems not to exceed 2⅔ sq. ins., and with a load of 2,000 lbs. on the wheel the actual pressure upon the pavement would be about 750 lbs. per sq. in. As the actual resistance to crushing of ordinary asphalt pavement in 2-in. cubes at a temperature of 50° F. was found by me to be about 1,500 lbs. per sq. in., such a load cannot be safely exceeded on this pavement, although when in place as a continuous sheet, lateral support undoubtedly increases very materially the resistance to crushing. The crushing strengths per square inch of other pavement materials are about as follows:

Good paving brick	10,000
Good granite block	17,500
White cedar block, dry	4,400
White cedar saturated with water (?)	3,000

None of these materials are, therefore, likely to be crushed by the pressure of ordinary wheel loads.

The function of the foundation of a pavement is twofold. First, to resist the tendency of the surface material to crush the foundation; and, second, to distribute the concentrated loads over a sufficient area of the sub-foundation, usually earth, to furnish a safe support. In the case of asphalt pavement the continuous sheet of asphalt mixture undoubtedly tends to distribute to some extent over the foundation the concentrated load applied to its surface. In the absence of data it is probably safe to assume that where the surface is 2 ins. in thickness, the lines of maximum pressure spread out at an angle of at least 30° from the surface pressed, so that if the area of surface pressure is $1 \times 2\frac{2}{3}$ ins., the pressure on the foundation will be $3 \times 4\frac{2}{3}$ ins., or say 14 sq. ins., equal to $\frac{2,000}{14} = 143$ lbs. per sq. in. In the case of all kinds of block pavement, where the blocks are free to move among each other, the pressure on each block is applied to the foundation direct, but not always in the ratio of the base of the block, since if the pressure is concentrated upon one end of a paving brick, for instance, the maximum pressure may be applied to as little as one-half the area of the base of the brick. Paving brick, as set, having usually a base of 3×9 ins. = 27 sq. ins., may, therefore, subject the foundation to a pressure of $\frac{2,000}{13\frac{1}{2}} = 148$ lbs. per sq. in. Granite blocks having a base of 12×5 ins. may give a maximum crushing force of $\frac{2,000}{30} = 67$ lbs. per sq. in., and in the case of round cedar blocks 6 ins. in diameter the pressure is about the same.

It seems, therefore, that we will be on safe ground if we assume that the foundation must be designed to withstand a crushing pressure steadily applied of 150 lbs. per sq. in.; but as the load, as applied, partakes of the nature of impact, we should, to feel secure, consider it as 200 lbs. per sq. in. Such loads do not approach the resistance to crushing of the weakest concrete in ordinary use, and not even that of ordinary crushed stone, fairly well compressed, and we may therefore con-

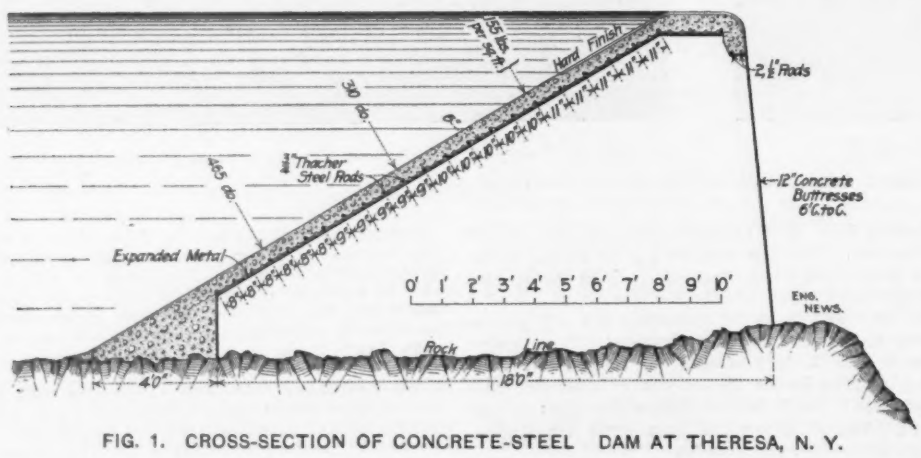

FIG. 1. CROSS-SECTION OF CONCRETE-STEEL DAM AT THERESA, N. Y.

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clude that any usual foundation, suitable in other respects, possesses the necessary strength to resist direct crushing.

While the sustaining power of such earth as is usually encountered in the sub-foundations of pavements varies considerably, we shall be well within conservative practice, even considering the tremors due to travel, if we call it 1½ tons per sq. ft. The problem is, therefore, to design a foundation which shall distribute the concentrated wheel load, which we have assumed to 2,000 lbs., over a sufficient area of sub-foundation so that the pressure upon it will not exceed 1½ tons per sq. ft. of surface. To consider this problem fully involves more detail than it is desired to introduce into this article, and only some general principles will be stated.

In the case of hydraulic concrete foundation, we may consider its action as analogous to that of a continuous girder, or, more correctly, to that of a circular plate fixed at its circumference and uniformly loaded; and having the necessary data, we may compute its depth or thickness as readily as we calculate the dimensions of a concrete beam. Such computations will show that neither so great a depth of foundation, nor concrete of so high a quality, is required, as many engineers assume to be necessary; or in other words, it seems probable that we are now inclined to lay undue stress upon the necessity of a thick bed of concrete of high quality, as necessary for pavement foundations. They will also disclose the relation between thickness of concrete and its quality, and may lead to considerable economy without sacrificing the strength or usefulness of the foundation. Experiments and deductions therefrom have shown that the actual strength of Portland cement concrete varies approximately with the ratio of cement to stone employed in its composition. In other words, concrete made in the ratio of 1 part cement to 8 parts of stone has approximately one-half the strength of that made with 1 part cement to 4 parts of stone (the ratio of sand being properly regulated). One barrel of cement (which is the most expensive ingredient) will make double the quantity of concrete in the first case as in the second; or if each is built into a beam of the same length and breadth as the other, the depth will in the one case be double that of the other, and while the strength of the concrete itself will in that case vary inversely as the depth of the beam, the capacity of the beam will vary directly as the square of its depth. If it be true, as suggested above, that concrete of a high quality is not necessary in pavement foundations, the consideration mentioned above may be of much importance in designing such foundations, and I may be pardoned for illustrating the principle further.

Suppose two beams to be constructed of Portland cement concrete, the concrete in No. 1 having the ratios 1 : 3 : 7 and that in No. 2 the ratios 1 : 6 : 11. (I use these ratios because we have the result of tests of beams of like composition in a paper by Elliott C. Clarke, C. E., Transactions Am. Soc. C. E., Vol. XIV., page 166.) If beam No. 1 be made 13½ ft. long, 1 ft. broad and 12 ins. deep, it will contain ½ cu. yd. of concrete. If beam No. 2 be made the same length and breadth as No. 1, but 24 ins. in depth, it will contain 1 cu. yd. of concrete. The cost of a cubic yard of concrete of each kind will be approximately as follows:

	⌐No. 1—1:3:7¬ Quantity.	Cost.	⌐No. 2—1:6:11¬ Quantity.	Cost.
Stone at...$1.20 per cu. yd.	1	$1.20	1	$1.20
Sand at.... .80 per cu. yd.	3/7	.34	6/11	.44
Cement at. 2.40 per bbl...	0.96	2.30	0.62	1.49
Labor and sundries		.70		.70
		4.54		3.83
½ yd. No. 1.....		2.27		

Using the coefficients deduced by Mr. Clarke, the breaking loads of the two beams on supports 13 ft. apart and loaded at the center would be:

$$\text{No. 1} = \frac{12 \times 12^2}{13} \times 9.8 = 1{,}302 \text{ lbs.}$$

$$\text{No. 2} = \frac{12 \times 24^2}{13} \times 6.2 = 3{,}296 \text{ lbs.}$$

If we divide the capacity of each by its cost we shall have,

$$\frac{1{,}302}{\$2.27} = 574, \text{ and } \frac{3{,}296}{\$3.83} = 861,$$

or, in other words, beam No. 2 gives 50% more strength per dollar expended than does No. 1.

There are considerations which modify and limit the application of this principle to pavement foundations, which I will not here take the time and space to discuss, but it must be apparent that opportunity for considerable economy is offered. The relative merits and economy of Portland cement and natural cement may be investigated in a similar manner and the result will be found to be strongly in favor of Portland cement; that is, for pavement foundation more strength can be realized per dollar expended, from Portland than from natural cement.

While the importance of adequate foundation for all pavements cannot be overestimated, I have for many years held that large sums of money are practically thrown away in American cities by making the foundations for many pavements unnecessarily strong, and as early as 1890 I advocated the use of natural cement concrete foundations 4 ins. thick under asphalt pavements, upon streets of comparatively light travel.

During the summer of 1890 a residence street in a western city was paved over such a foundation, and subsequently some tests of its strength were made under the direction of the city engineer, which may be worth recording for the use of the profession. The sub-foundation was very unsatisfactory, being of soft wet clay, which had been much disturbed by many trenches for sewers, water and gas pipes. After grading and rolling with a five-ton roller, the concrete foundation 4 ins. in depth, composed of 1 part natural (Louisville) cement, 2 parts sand and 5 parts crushed stone was laid, and the asphalt surface, 2 ins. thick, was in due time put in place. In April, 1902, the strength of the pavement was tested by hauling over it from end to end and return, with occasional stops, a truck weighing with its load, 22,300 lbs. The load was so distributed that each hind wheel carried slightly over three tons. The

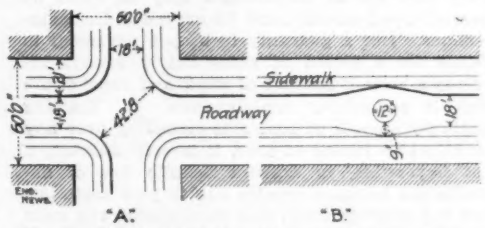


Fig. 3. Plan of Street with Long Radius Corners and Turnouts at Center of Block.

tires were 4 ins. wide. No effect was produced upon the pavement, except that at one spot where the truck was stopped for thirty minutes, slight impressions were made by the wheels in the asphalt, the day being warm. The pavement is still in use and the foundation has shown no signs of failure. This test and other experience seems to prove that such a foundation is ample for the great majority of residence streets. In fact, it may be doubted whether for most streets, particularly those paved with materials other than asphalt, a concrete foundation is at all necessary. A foundation of moderate thickness of broken stone, well compacted by rolling, would undoubtedly be ample. This is proved by the very many examples of brick and other block pavements laid on such foundations, which, where properly constructed, have given entire satisfaction.

It must be obvious that in the matter of pavement foundations, as well as in all other details of street pavement construction, there is need of, and a very promising field for, the application of sound engineering principles supplemented by intelligent observation and experiment.

VIII.

Width of Paved Roadway.

The enormous sums of money invested in street pavements in our cities has been referred to in these articles. Upon the whole, this money has been wisely invested, since well paved streets are, in most cases, profitable. There is, however, room for question in many cases whether the money has been spent to the best advantage, or, in other words, whether equally good results could not have been attained at a much lower cost. It is quite certain that in a great many cases money is wasted by paving street roadways wider than necessary. A large percentage of the pavement in American cities is found on residential streets having comparatively little travel. Such streets are generally, and with good reason, designed of liberal width—from sixty to one hundred feet between the property lines. Sometimes city ordinances, but more frequently-established customs, fix the relative division of the whole width between roadway and sidewalks, and considerations of this kind, rather than those of utility or of good taste, too often determine the width of the paved roadway. And yet a little thought should, and generally will, convince even the most obtuse mind of the absurdity and the extravagancy of such a practice. The most stupid servant will hardly ever be found carrying a bushel basket to market when her sole object is to buy and take home a dozen eggs.

It is not unusual to find residence streets 60 ft. wide originally laid out with 12-ft. sidewalks, thus leaving a roadway 36 ft. wide, paved from curb to curb. The sole travel over the street consists of a few private carriages and the delivery wagons that supply goods of various kinds to the residents. All that such a street requires is a paved roadway of sufficient width that two vehicles may meet and pass without interfering with each other. A roadway 18, or at most 20 ft. wide is ample for such purposes, and where this is so, every cent expended to pave and maintain a wider roadway is absolutely thrown away; or rather it is worse than thrown away, as I shall show later.

What are the objections to these narrow paved roadways? In a majority of cases the first objection to be raised will be "we have never seen it done that way," and it must therefore be wrong. The intelligent engineer needs not to be told how to meet this argument, which doubtless had its origin early in the career of Adam. Next it may be asserted that teams cannot turn around in such a narrow roadway. Excepting one-horse vehicles, this is true. It may be replied, however, that unless the blocks are unusually long it is not necessary for teams to turn around; they can, if they wish to reverse their direction, go around the block. The inconvenience, time and cost of doing so once or twice a week will be insignificant compared with the money saved by reducing the width of the pavement nearly fifty per cent. If, however, the objection is still insisted upon, room for turning around on every block may be provided without abandoning, in the main, the narrow roadway. This may be accomplished in either of two ways, shown by Fig. 3. By giving the curb at the street corners a long radius, sufficient space will be obtained at the street intersections to allow any ordinary vehicle to be turned, as shown at A; or a turning place may be made in the middle of the block, as shown at B. In the center of this widened spot may be placed a flower plot or a fountain, thus greatly enhancing the beauty of the street. If there are any other valid objections to the narrow roadway they have not come to my attention.

Where are its advantages?

1st.—A very great reduction in the cost of paving the street. In reducing the roadway from 36 to 20 ft. we shall reduce the cost in very nearly the same ratio. The cost per square yard will be just about the same in each case, but the circular turn in the middle of the block, or the larger paved area at the intersections, and the greater quantity of circular curbing would reduce slightly the saving that would otherwise be made.

2nd.—The cost of maintaining, cleaning and sprinkling the pavement will be decreased in the same ratio. When not sprinkled there would be less surface to collect and scatter dust.

3rd.—Widening the boulevard or sidewalk space would increase the lawn space in front of the residences; it would practically increase by that much the available size of the lots.

4th.—All kinds of pavements reflect the heat of

the sun to a much greater extent than does a grass-covered surface, and the narrower pavement would thus tend to lessen the excessive summer heat in the residence districts.

5th.—Narrowing the width of the paved roadway would improve the appearance of the street. Well-kept sward is vastly more pleasing to the eye that an expanse of bare pavement.

6th.—There would be room to place water and gas pipes, conduits and sewers in the boulevard between the curb and the property line, where they would be more accessible than under the street pavement, which would not have to be cut out and afterward replaced whenever repairs are made to such underground structures. This construction implies duplicate pipes, etc., on each side of the street, but the additional cost would not be great and the saving in the cost of repairs would be more than sufficient to cover this slight additional cost in original construction.

If the assertions in 2, 3, 4 and 5 above are well founded the narrow roadway, aside from its lower first cost, is actually better than the wide roadway, and consequently the money expended for constructing the additional width is worse than thrown away.

I have, of course, assumed an extreme, though not at all an unusual case. Between it and the crowded business street, where the widest possible roadway is necessary, will be found intermediate conditions requiring the adjustment of the width of roadway to the volume of travel provided for. What I desire to call attention to is the common-sense rule that consideration of the quantity of travel to be accommodated, rather than any rigid ratio between width of roadway and width of street, should control in fixing the width of paved roadway. The volume of travel may, of course, so increase after the pavement is constructed that a very narrow roadway may be inadequate, but this will not usually occur during the life of the ordinary pavement; and even if it should, the cost of setting back the curbing and paving the additional width required, would not greatly exceed the original cost of the wider pavement, and the interest for several years on the money saved would more than cover the slight additional cost thus incurred.

I am well aware that what is said above is neither original nor novel. I have been advocating narrow-paved roadways for streets of light travel for many years, and not a few others have done what they could to prevent the wanton waste of money in building wide pavements where there is neither need, nor even valid excuse for them. The public, who take little interest, as a rule, in municipal public works, may be excused for their thoughtlessness or unconcern, but what about the municipal engineer, who is supposed to keep abreast of the times, and to look after the interests of the people who employ him?

IX.

Contractors' Guaranties on Pavements.

The question whether it is wise to require from contractors long-period guaranties on the pavements constructed by them is one of business policy rather than of engineering, but it is a question with which municipal engineers are concerned and must often deal. It seems to have been generally assumed in the past that the municipality can lose nothing and must gain much by requiring such guaranties; and that the longer and more exacting they can be made the better are they for the interests of the city. More recently this assumption is being questioned by some, and the merits, demerits and limitations of the practice are being investigated.

It is not possible in a brief space to discuss the subject satisfactorily, but a few leading considerations may be presented.

The legitimate purpose and scope of a contractor's time-guaranty on pavements may be:

1st.—In the case of new kinds of pavement, with which the engineer or the public may not have had sufficient experience to judge correctly of its merits, the contractor or promoter may be required to make good his claims regarding it. In other words, if opportunity for trial is given, the promoter must assume responsibility for promised results. There can be no reasonable objection to guaranties of this character if they can be legally entered into and enforced.

2nd.—In the case of the standard kinds of pavement, whose good and bad qualities are well known, and the processes of their construction well understood, the object of a guaranty is to compel the contractor to use suitable materials and proper care and skill in carrying on the work, by making him, rather than the city or its agents, responsible for results. Any just and reasonable measures that will tend to secure compliance on the part of the contractor with the terms of his contract are worthy of careful consideration, and if long-time guaranties serve this purpose without leading to dangerous complications and without unduly increasing the cost of the work, they are not only unobjectionable, but commendable. The question whether they are fair and just to the contractor need not here be discussed, and we may confine ourselves to the question, are they, upon the whole, advantageous to the city?

The arguments that may be advanced in favor of such long-time guaranties are the following:

1st.—They place upon the contractor the responsibility of doing the work in full accordance with the plans and specifications.

2nd.—They relieve the municipality of the cost of keeping the pavement in repair for a period of years after its construction.

On the other hand, the arguments against the advisability of such guaranties are the following:

1st.—Their legality is not only not well established, but is open to serious doubt. In cities where pavements are paid for from the general funds the right of the municipality to make contracts covering not only the construction of a pavement, but its subsequent maintenance has never been seriously questioned. But where the pavement is to be paid for wholly or partly by special assessments on the property benefited, the case is different.

Statutes authorizing special assessments usually either stipulate or imply that the proceeds from such assessments can be used for construction alone, and must not be applied to maintaining the work after its completion. In order, therefore, that special assessments may be valid, no part of the proceeds must be expended for maintenance. But a guaranty to keep a pavement in repair for a period of years nearly always involves a certain amount of work and expenditure that is undeniably maintenance. In framing guaranty clauses of contracts extending over any considerable period of time, it is very difficult, if not impossible, to draw a definite line of demarkation between repairs due to poor materials and bad workmanship, and those due to the wear and tear of use, which would exist however well the work may have been originally done. Because of this difficulty guaranties are admittedly drawn so as to cover both these classes of repair, during the life of the guaranty.

The question of the legality of guaranties that involve maintenance where the work is wholly or partly paid for by special assessments, has been passed upon by the courts of only a few of the states. The great majority of the decisions have been to the effect that such guaranties are illegal. The few decisions to the contrary seem to be based upon assumptions that do not appear tenable in the light of practical fact and experience. Some of these assumptions are: (a) That the guaranty is merely an evidence of good faith, and that the contractor does not add anything to the price of construction to cover maintenance during the guaranty period. This is not only improbable on its face, but as a matter of fact is not true. (b) That the guaranty requires the construction of a pavement of such quality that no maintenance repairs will become necessary during the time guarantied; and if they do become necessary, the fact must be regarded simply as evidence that the contractor has not properly performed the work. Such an assertion is not only far-fetched, but is unsupported by the facts. It assumes that the processes of natural decay and the destructive effects of travel are suspended during the guarantied period, since, otherwise, these causes may render necessary repairs that are not due to defective construction alone.

In practice no attempt is usually made to discriminate between these two classes of repairs, and it is well understood that, barring certain extraordinary injuries, the contractor is required to keep the pavement in repair whether the repairs are made necessary by failure to construct the work properly, or by the wear and tear of use. It seems therefore most probable, if not certain, that the courts of those states where the legal question has not been adjudicated, will pronounce invalid special assessments, a part of the proceeds from which are admittedly to be expended for maintenance. If it were shown in a given case that the contractor not only did not anticipate when he undertook the work that any repairs would become necessary, but that he actually made no repairs during the guarantied period, there would seem to be no cause for action. But this suggests an interesting question that seems not to have been brought before the courts so far. Two streets in the same city are paved at the same time, by the same contractor, under the same specifications, and with identical materials and equal skill. The pavements when completed are duplicates in all essential matters. Each pavement is guarantied by the contractor for, say, five years. One of the streets carries but little travel, while the other is subjected to very heavy travel. The one may require no repairs during the five years, while the other may be so worn during that time as to require very costly repairs.

If the contractor, knowing these different conditions of use, charges a much higher price for paving the one street than for the other, is it not clear that the additional price is intended to cover the cost of maintenance of the heavy traveled street? And where the cost of paving that street is specially assessed upon the abutting property-owners, is it not clear that a part of the proceeds of such assessments is applied to paying for maintenance?

There is another feature of the usual guaranty contract that deserves more consideration than it has received by the courts. Where the character of the materials to be used, and the processes of construction required are fully and definitely set out in the specifications, to what extent may the contractor be required to guaranty that certain results will be produced? If it be specified that the numbers three and four shall be added together, and that the sum shall be eight, the person performing the operation is not blamable if the true sum turns out to be seven. So if the contractor constructs a pavement in strict accordance with specifications that describe definitely and minutely the materials to be used and the methods to be followed, he cannot justly be required to guaranty that the product shall possess certain qualities. I am not aware that this particular phase of the question has been brought squarely before the courts, but until it is definitely settled that a city may both prescribe methods and require stipulated results therefrom, the guaranties now common in paving contracts must be looked upon as of questionable validity.

The legality, therefore, of long-period guaranties upon pavements seems to be open to such grave doubts, in all those states where the courts have not passed favorably upon their validity, as to render their employment inadvisable, if not positively dangerous.

But aside from their legal aspect it may, I think, be shown that long-period guaranties are not generally advantageous to the city. Honest and responsible contractors neither do work nor undertake risks without proper compensation. They can generally compute very closely the cost of constructing a pavement, but they cannot with reasonable certainty estimate the cost of keeping it in repair for a considerable period of time. Even if it were only a question of the quantity of travel to which the pavement may be exposed, they would be unable to do so. The effect of a good pavement in attracting to and increasing the travel upon a given street cannot be accurately foreseen. This is particularly true in our rapid growing American cities with shifting centers of traffic. The contractor cannot know to what adverse conditions of use or misuse the pavement may be subjected. Furthermore, guaranties, as

usually drawn, cover repairs other than those caused by legitimate use of the pavement, due to causes for which the contractor may not be responsible, and over which he may have no control. They are still frequently so framed as to cover accidental or malicious injuries to the pavement. The contractor in fixing the sum he must add to the cost of construction to cover the cost of maintenance, must take all these things into consideration, and if he be prudent, he will add a sum that will surely cover all contingencies. Consequently, the city is almost certain to pay extravagantly for the maintenance covered by the guaranty. Again, certain classes of repairs that always become necessary, are not embraced in the guaranty; such, for instance, as cutting out the pavement for constructing or repairing underground structures. It is, however, found necessary, for reasons which need not be given here, to provide that such repairs shall be made by the contractor guaranteeing the pavement, and prices for these repairs are usually stipulated in the original contract. This is not usually considered a matter of much importance in framing the original contract, and the prices allowed are very likely to be, or to become before the expiration of the guaranty, excessively high, and very burdensome upon the city or the private parties who must pay for such repairs. There are plenty of instances where these repairs are the chief source of the contractors' profit, and where exorbitant prices are now, and must continue for years, to be paid for such repairs.

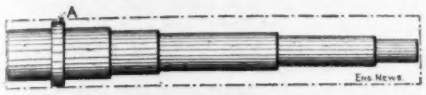


Fig. 1. Spindle Suitable for Manufacture in Rapid Reduction Lathe.

A guaranty to be of value must be enforcible; and to this end the city must exact from the contractor ample security that the guaranty will be complied with. Whether the cause of failure be poor construction, or excessively heavy travel, or accidental injuries (often covered by the guaranty), it not infrequently occurs that the cost of keeping the pavement in repair will amount to as much as fifty per cent. of the contract price, and if the city is to be properly secured, surety equal to half the value of the contract must be insisted upon. Such an amount of security, whether provided for by retaining a part of the contract price, or by requiring a satisfactory bond for an equal amount, is likely to be so burdensome upon the contractor as to compel him to provide for it in his bid. Except he be possessed of unlimited capital he cannot long continue in the business unless he charges prices that, after deducting a large retained percentage, may be sufficient to meet his outlay, or if the security be in the form of a bond, that will be sufficient to pay the premium upon such bond. In either case he must add a considerable sum to the cost of construction and maintenance, which in the end the city must pay. The very high prices paid for asphalt pavements where a fifteen-year guaranty has been exacted, furnish a fine illustration of the effect of long-time guaranties upon the cost of pavements, and show what a high premium the city must pay for this species of insurance. Nor is the work of maintenance, under these guaranties, always promptly and properly done. Contractors receive no immediate pay for this class of work, and are therefore prone to put it off as long as possible, even though it may be poor economy on their part to do so. The city is often not in a position to enforce prompt attention, and the result too often is, that many streets are constantly in bad repair. Not only better but more prompt service would be secured if the repairs were made under a separate contract where the contractor would be paid directly for the service when it should be completed.

Statistics, so far as they are available, seem to show that the average cost of maintaining pavements for the first five years or the first ten years of their life, is materially below the sums that contractors add to the cost of construction for the purpose of covering a guaranty for the same periods, and if this be true, no further proof is required that cities pay for maintenance by the guaranty method prices that are far too high.

There seems to be no valid reason why, in contracting for well-known kinds of street pavements, the same procedure should not be followed that has been found most satisfactory in other branches of municipal public work. That is, to specify definitely and percisely the quality of the materials to be used and the manner in which the work shall be done, and then to enforce compliance by the contractor. The city would then know definitely what it is to get, and the contractor would be able to estimate with a fair degree of accuracy the cost of the work he is to do. In other words, it would not be necessary for him to combine in his business the functions of the contractor, the prophet and the insurance company, at the expense of the city.

What has been here said applies to long-time guaranties only—five or more years. A guaranty covering a period sufficient on the one hand to disclose defects of material or workmanship that may have been overlooked, and short enough on the other hand to practically exclude maintenance, is not objectionable, and while the proper period may vary with different conditions, and with different kinds of pavement, it should not exceed two, or at the very most, three years. If, after the expiration of such a short guaranty, it is deemed advisable to maintain the pavement by contract for a period of years, it may usually be done, not only upon more favorable terms than could be secured through a long-period guaranty, but without incurring the danger of legal complications.

RAPID REDUCTION IN THE LATHE AS COMPARED WITH FORGINGS.

By Frank B. Kleinhans.*

The cost of forgings is a large item of expense in many manufacturing concerns. It is surprising to note the enormous increase in price per pound which must be paid for a forging of even the most simple character, as compared with standard rolled sections. Any means of reducing this cost will be welcomed by the manufacturer. In many manufacturing concerns, brass and gun metal have been superseded by steel and cast iron in order to reduce the cost of from 18 to 25 cts. per lb. to 3 or 4 cts. per lb. If by some means a price of 10 or 12 cts. for forgings can be reduced to half the amount, a large saving will be effected.

*2641 Stanton Ave., Cincinnati, O.

Fig. 1 represents a lathe spindle. The manufacturers are obliged to purchase the forgings for these spindles as they have not the facilities for making the forgings themselves. The usual process in such cases is to furnish a blue print of the rough dimensions. The forgings are then made up according to the figures on this print, and in order to be sure that enough finish is allowed, it is necessary to pay for considerably more material that is actually wanted, after which additional expense is necessary to machine off this material.

This forging can be made of a bar 4 ins. in diameter, as the largest portion at A is 3¼ ins. In looking at this bar we can see that if the metal could be rapidly and cheaply removed from the outside by some means or other, we would have a much more satisfactory job and it would cost less than the forging.

This has actually been done in a number of cases and the price of the finished product has been greatly reduced. Doubtless in the near future much of the work which is now forged can be much more cheaply produced by this process of rapid reduction.

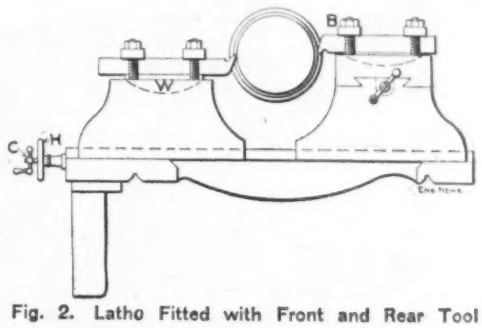


Fig. 2. Latho Fitted with Front and Rear Tool Posts for Rapid Reduction.

In Fig. 2 is shown an ordinary lathe carriage fitted up for this class of work. It will be seen by referring to the figure that two slides are provided with the regular dove-tail of the carriage and are entirely independent of each other. The front tool is adjusted longitudinally by moving the carriage, while the rear tool has an independent slide for its adjustment. The tools are provided with a wedge W, which has a circular bottom fitting snugly into a corresponding slot. By this means the tools can readily be adjusted to the center. The five clamp bolts B hold the tool down firmly for heavy cuts.

On large lathes the front and the rear tool block can be operated, the one by means of a screw which is already in the lathe, and the other by means of a screw which is in place of the spline shaft. In the smaller size lathes, however, the most convenient arrangement is shown in Fig. 2. The front slide is operated by means of a screw of large diameter which is keyed to the hand wheel H. This screw is hollow and through its center passes a shaft C, which carries the screw on the rear end. This screw engages with the back rest. It is operated with the ball crank C.

Another arrangement of the tools for rapid reduction is illustrated in Fig. 3. The tools in this case are arranged side by side and are fitted up with narrow slides so as to admit of the tools being placed very close together. B represents the

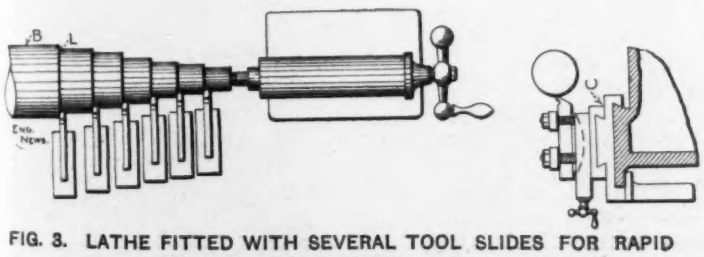


FIG. 3. LATHE FITTED WITH SEVERAL TOOL SLIDES FOR RAPID REDUCTION.

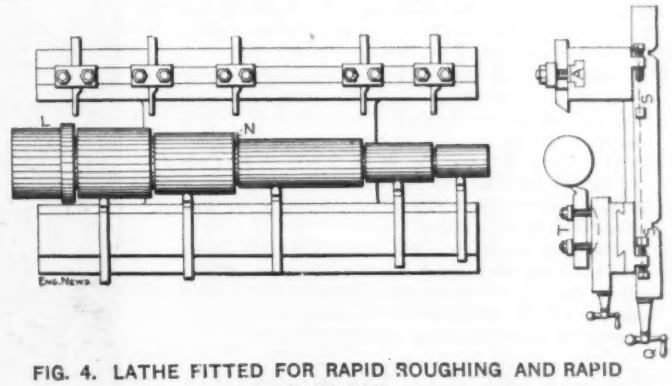


FIG. 4. LATHE FITTED FOR RAPID ROUGHING AND RAPID FINISHING.

bar which it is intended to reduce for a certain distance. As each one of the tools come up to the line L, where the reduction is intended to stop, each tool is withdrawn independent of all others. The arrangement of the carriage, etc., is shown at the sectional view at C.

By this multiple arrangement of tools and by the use of high speed tool steel, we are enabled under certain conditions to take a heavy cut at a speed of 150 ft. per minute. Of course a flow of water must be kept on each tool.

We have one other advantage in machining the spindle by this arrangement of multiple tools. Thus in Fig. 4 we again have this same spindle shown. The front tools T are arranged with independent adjustment and are set up so as to turn to within a few thousandths of grinding size. After the spindles have all been roughed off, with only a little finish allowed, they are caught with a lathe carrier at L, then the whole slide, carrying all the tools that are shown, is moved bodily inward against the stop S, which gives us the proper diameter. The power feed is then thrown in and the tools are allowed to run to the end of the steps, as shown. The end tool nearest the tail stock must be withdrawn in starting the cut as some of the steps are longer than the others. It is then fed down against the stop and thus gives the proper diameter. For grinding this spindle, it is necessary to have it nicked at N. This special slide is arranged as shown and has a tee slot along the top portion at A, into which a gib and a pair of clamp bolts are fitted. The tools are adjusted along this slide to fit the grooves on a spindle which has already been turned up. The ball crank Q is then turned in a direction so as to bring these tools against the work. The back stop S gives the proper depth. The top slide is not clamped to the bottom by any special arrangement of bolts. When the stops S and S at each end of the carriage are reached, the ball crank Q is then given a hard extra turn, the slide is thus locked firmly in position.

Of course this spindle has only been used as an example of a very large variety of work which can be done in this manner, and thus considerable saving can be effected by changing over from forging to this method of rapid reduction.

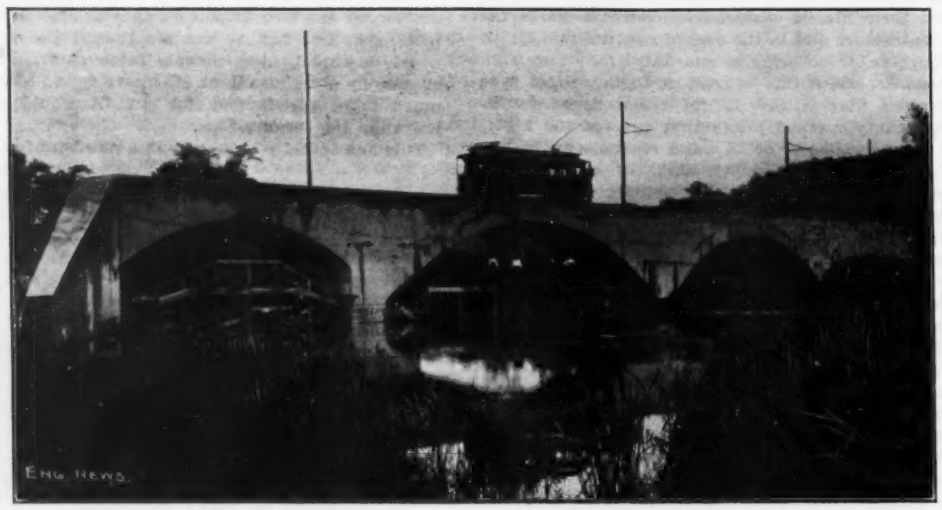


FIG. 1. CONCRETE ARCH BRIDGE NEAR MECHANICSVILLE, N. Y.

A CONCRETE ARCH BRIDGE NEAR MECHANICSVILLE, N. Y.

An interesting piece of concrete work, both from an engineering and a contracting point of view, is the three-arch highway bridge over a mill pond on the Anthony Kill between Mechanicsville and Round Lake, N. Y.

The work, as shown in Fig. 1, consists of an abutment for the easterly end of steel bridge over the Delaware & Hudson and Boston & Maine Railroad tracks, with retaining walls running easterly about 75 ft. to join the parapet walls of the three arches that span the mill pond. The first two arches have a span of 100 ft. each and the third a span of 50 ft., with a rise of 20 ft. from the spring line of the large arches. The length of the continuous structure is 330 ft., and the width between outsides of parapet walls is 17 ft. Rock foundation was found at a depth of less than 12 ft. for all parts of the structure.

The contractors, Warner & Madigan, of Mechanicsville, N.Y., were made responsible for the safety of the work, and built the centering according to plans of their own that are in some respects unique. Four-pile bents were driven through the mud of the river bottom to rock; the piles being spaced 6 ft. between centers and the bents 10 ft. apart. The piles, as shown in Fig. 2, were capped with 10 × 12-in. pieces drift-bolted to place, and four lines of 10 × 12-in. stringers were drift-bolted to the caps, bringing the structure about 4 ft. above the elevation of the spring line of the arches. 8 × 10-in. posts spaced 3 ft. from centers were erected on the stringers, and cut at such lengths that the caps on the tops of the posts conformed to the curve of the arch. These caps were 8 × 10 ins. and 23 ft. long, projecting 3 ft. beyond the lines of the arch for convenience in bracing the forms for the parapet. The top faces of the top caps were beveled to conform to the curve of the arch. The lagging was then put on *parallel to the center line* of the structure, and sprung down and nailed to place over the caps. This lagging was put on in two thicknesses of inch boards. Rough boards were used for the first course, and good stock, planed on the upper surface and carefully jointed and laid, for the top course, making a smooth surface for the concrete. Hardwood wedges were used under the posts for convenience in removing the centers.

140,000 ft. B. M. of lumber were used in centers, forms and braces; none of it being used but once. About 2,500 cu. yds. of concrete were required for the work. There were no expansion joints, and no iron was used in the structure, except five ribs of old street railway 7-in. girder rails, which were placed about 4 ft. apart in each arch, bent to the form of the arch, tied together with splice bars and bedded in the concrete about 6 ins. above the lagging. The spaces between the parapet walls and over the arch spandrils were filled with gravel for the track roadbed.

The concrete was made of one part Alpha Portland cement, three parts sand, three parts gravel and three parts broken stone for all parts of the structure, except the arch sheeting, in which the gravel and broken stone were reduced to 2½ parts each. The sand and gravel were of excellent quality, and the stone was crushed cobblestones from local fields and fences. The plant was located on a side hill close to the east end of structure, and consisted of a 40-HP. boiler and engine, in front of which was the stone crusher, and in front of that the mixer, all compactly connected together. At the right of this plant and in line with the center of the structure was a double-drum hoisting engine, the two drums of which were used to run a cableway by which cars of concrete were hauled from the mixer over the arches and back past the mixer, by a short turnout, to be refilled. A short conveying belt ran from the crusher screen, so that by a turn of a lever the broken stone would run from the screen into the hopper of the mixer. A medium-sized crusher and rotary mixer were used. The cars from the mixer ran on a 3-ft. gage temporary track over the center line of the arches, and were built to dump either way. This arrangement of plant reduced the number of laborers required to nine, and from 50 to 60 yards of concrete were put in place in 10 hours.

The structure has been in use by heavy trolley cars running at high speed for over a year, and the test has shown that large concrete arches of monolithic structure can be built cheaply, quickly and with ample strength and durability for practical uses.

FIG. 2. SHOWING NOVEL CENTERING OF CONCRETE ARCH BRIDGE NEAR MECHANICSVILLE, N. Y.

THE PLANT OF THE BUCKHORN PORTLAND CEMENT CO.

By Richard L. Humphrey.

Within the borders of the State of West Virginia, where the Cheat River flows through the heart of the Allegheny Mountains at their most picturesque point, is located one of the most unique Portland cement plants in this country. It is unique in that it is built on the side of the mountain from which is obtained the raw material, quarried at a point over 400 ft. above the upper part of the mill, and over 500 ft. above the stock house in which the finished product is

*Consulting Engineer, 1001 Harrison Building, Philadelphia, Pa.

stored. A gravity plane delivers the raw material from the quarry to the mill. The plant was designed with a view to having a gravity feed through the mill, thus reducing to a minimum the number of elevators required. Another interesting feature is the transmission of power from a central power house to various points in the mill by means of manila rope drives.

The construction of the plant has been considerably handicapped through lack of funds and legal difficulties. The original company became involved in a law suit with its creditors, which was finally terminated in the sale of the plant and property by order of the U. S. Court on Dec. 12, 1901. The purchasers organized the present company under the laws of the State of New Jersey, retaining the name of the old company. It was not until a year later that the finances and organization of the new company were in shape for the resumption of work on the plant, which was completed and placed in successful operation during the summer of the present year.

The construction of the plant upon the mountain side was attended with many difficulties, which delayed its completion and increased the cost. Notwithstanding the surface indications, no solid ledge of rock was uncovered by the excavations, and a series of walls had to be built to retain the embankments. These walls averaged 16 ft. thick at the base, and were built of a blue sandstone, quarried near the site, laid in Portland cement mortar. The material excavated consisted of a blue and red clay interspersed with large and small stone. The sliding of large portions of the embankments into the excavations, occasioned by the numerous springs which percolated the material, was of frequent occurrence.

With the exception of the stock house, office and laboratory, and the upper portion of the stone house, all the buildings are built of blue sandstone, the walls being 24 ins. thick for the single story, and 30 ins. thick for the two-story buildings. The roof of the stock house is covered with corrugated iron, that of the office and laboratory is shingled, the roof of the kiln room is a steel skeleton covered with corrugated iron, while the roofs of the other buildings consist of steel beams sheathed and covered with slag.

In describing the plant more particularly, it may be well to follow the course of the raw material from the quarry through the mill to the stock house.

QUARRY.

The deposit of limestone from which the raw material is obtained, can be traced by its exposures along the face of the mountain, dipping to the northwest at an angle of about 14°, and pitching into the mountain at a low angle above the horizontal. These exposures can be followed from the bed of the Cheat River, along the face of the mountain to a point above and slightly to the left of the mill, where the outcroppings form a bench for a distance of about 2,000 ft.

Back of the crest of this ledge, the surface of the bench rises very gradually for a distance of several hundred yards, until the main slope of the mountain is reached. The stripping required to uncover the ledge is not excessive, and there is apparently an inexhaustible supply of limestone.

The deposit, which is a fossiliferous limestone of the sub-carboniferous formation, is in two ledges, the upper over 70 ft., and the lower about 20 ft. in thickness. The two ledges are separated by sandstone about 100 ft. in thickness, which renders the lower ledge unavailable save by mining. The pitch of the ledges affords ample fall for free drainage, and for handling the stone to the incline. The various strata of which the upper ledge is composed are well defined, rendering their separation in the quarry a comparatively easy matter.

The chemical analyses of this material show it to be of exceptionally good quality for the manufacture of Portland cement. The composition varies from a low-limed argillaceous rock to a nearly pure limestone. Nearly one-third of the deposit has the composition for a correct mixture, and requires no admixture of other material. The following are representative analyses of the different strata:

	Strata		
	Lower.	Middle.	Upper.
Si_2 O	23.40—20.20	18.60—13.08	8.84— 2.92
Al_2 O_3 ..... / Fe_2 O_3	9.10— 8.80	7.60— 6.12	5.04— 1.82
Ca Co_3	60.31—68.89	72.27—80.09	85.00—94.00
Mg Co_3	Trace.	Trace— 0.61	0.72— 1.10

The present mixture is obtained by blending the lower and middle strata. That the mixture is satisfactory is evident from the quality of the cement produced, and the fact that the kilns produce over 200 barrels per kiln per day.

This mixture can possibly be obtained by blending the different strata for some time. It is probable, however, that the ledge as a whole will be too high in lime, and will require the addition of clay or shale in order to obtain the proper mixture.

Deposits of clay and shale are to be found in the flat adjacent to the mill and along the line of the Cheat Valley Railroad, and have the following composition:

	Shale.	Clay.		Shale.	Clay.
Si_2 O....	62.74	68.16	Ca Co_3....	0.38	0.42
Al_2 O_3.... / Fe_2 O_3...	19.40	16.18	Mg Co_3....	1.41	1.04

These deposits taken in conjunction with the limestone deposit, are sufficient to operate the plant for an indefinite period.

The drills are driven by compressed air supplied through a 4-in. pipe line from the compressor, which is located in the power house at the bottom of the plant.

INCLINE.

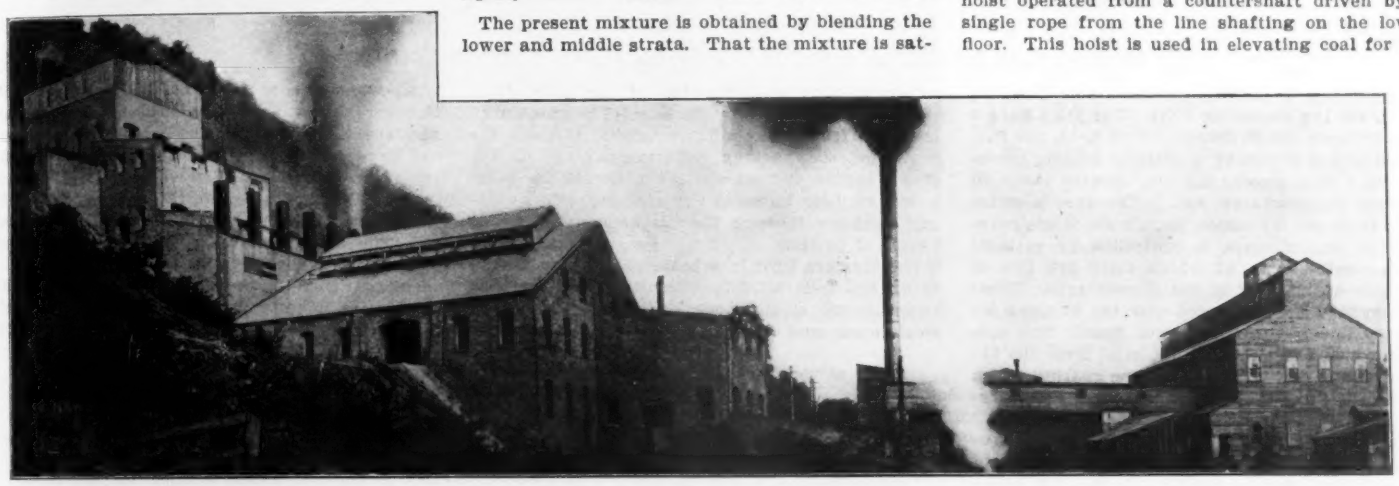
The delivery of the stone from the quarry to the mill is effected by means of two 5-ton steel side-dump cars, operating on a gravity plane about 900 ft. long, and having a slope of about 36°. The plane consists of a three-rail track, extending from the top for a distance of 340 ft. to a double track parting in the middle of the incline, 235 ft. long, which enables the descending and ascending cars to pass each other. This parting merges into a lower single-track section about 340 ft. long, which ends on the top of the bins at the stone house.

A self-acting switch at the lower end of the parting guides the car alternately from one to the other of the upper tracks, the descending car setting the switch for its return on the same track. The two cars are attached to the ends of a steel hoisting cable, which winds around a pair of sheaves (located at the top of the plane), controlled by a band brake; the loaded descending car returning the empty.

The mixture is made at the quarry as the cars are loaded with a predetermined number of wheelbarrows of high and low-limed rock. The composition of this mixture is checked in the raw material ball mill room, and should it prove too high or too low in lime, the necessary correction is made at the crushers on the upper floor of the stone house, for which purpose a supply of high and low-limed rock is stored conveniently near these crushers. As soon as sufficient room can be made by quarrying, the "mix" will be made, and the stone will be crushed at the quarry.

STONE HOUSE.

This building consists of two floors, the upper of which serves as a storage for stone for use when the quarry is not being operated. The rock is fed into the crushers from this floor. A steel jaw crusher, having a capacity of 30 tons per hour, is in use at present. On this floor is located a belted hoist operated from a countershaft driven by a single rope from the line shafting on the lower floor. This hoist is used in elevating coal for the dryers, and any clay or shale that may be required.



GENERAL VIEW OF BUILDINGS OF BUCKHORN PORTLAND CEMENT CO., ON CHEAT RIVER, W. VA.
Richard L. Humphrey, Chief Engineer.

The cars from the quarry dump into a set of five bins, which hold sufficient stone to last several days. From these bins the stone is fed through chutes into the crusher, in which it is reduced so as to pass a 1½-in. ring; from this crusher it falls into a rotary dryer, and from the latter into smaller jaw crushers, which reduce it to ¾-in. size.

There are two rotary dryers located on the lower floor; one, built by Wm. F. Mosser & Son, consists of a single shell 40 ft. long and 4 ft. in diameter, having a brick fire-box at one end, a brick dust chamber and a stack at the other. The other dryer was built by the Ruggles-Coles Engineering Co., and consists of an outer shell 24 ft. long, 5 ft. in diameter, and an inner shell, 30 ins. in diameter; an exhaust fan, which takes the place of a stack, maintains a constant draft, capable of regulation. The fire-box and fan are at the feed end of the dryer, and the heated air, passing through the inner shell and returning between the inner and outer shell, is ejected by the exhaust fan.

BALL AND TUBE MILL ROOMS.

From the small crushers the stone passes through chutes into the steel hoppers feeding the Smidth ball mills, in which it is reduced to pass a sieve having 12 meshes per lineal inch. Screw conveyors deliver the product of these mills into the hoppers feeding the Smidth tube mills, in which the raw material receives its final pulverization, and leaves the mills so finely ground that 95% will pass a sieve having approximately 10,000 meshes per square inch. The raw mixture thus prepared

is stored in a large bin in the upper end of the kiln room.

KILN ROOM.

This department is a model of its kind. In the rear is the raw material bin having six compartments, each holding sufficient material to operate each kiln 24 hours. A short screw conveyor in the bottom of each bin feeds the material into the kiln through a water-jacketed chute.

The six kilns are each 60 ft. long and 6½ ft. in diameter for a distance of 30 ft. from the discharge end; a 10-ft. taper reduces this diameter to 5 ft. for the remaining 20 ft. The kilns have a pitch towards the discharge end of ¾-in. per ft.

Each kiln is driven by a chain of gearing meshing into a rack around the kiln, located about 20 ft. from the discharge end. The speed, which varies from one revolution per minute to one revolution in two minutes, is controlled by variable speed countershafts, of which there are two of the Reeves and four of the Mosser type. These countershafts are connected with the kiln gearing and the line shafting by bevel gears. The conveyor which feeds the raw material from the bin to the kiln is driven from the same gearing which rotates the kiln; the feed of raw material, therefore, varies directly with the speed of the kiln.

Each pair of kilns discharges through a fire-brick-lined chute into the boot of a single chain open elevator. As the clinker falls into the buckets of this elevator, it is sprayed with water. The elevator dumps the clinker into a cooler built by Wm. F. Mosser & Son. There are three of these coolers, each 32 ft. high, 8 ft. in diameter, having a cast-iron blast pipe running through the center, with sheet-steel conical shields every 5 ft., extending to within 10 ins. of the shell of the cooler.

Under this shield are holes in the blast pipe, through which a constant flow of fresh air is maintained by means of a fan, the air passing out of the cooler through holes in its shell, the latter having conical shields on the inside just above these openings.

The heat of the clinker is absorbed in the vaporization of the water and is removed by the current of air which passes through the thin stream of clinker moving through the cooler between the two shields.

The coolers rest on a cast-iron plate, supported by foundations 4 ft. high, in a pit about 20 ft. below the kiln-room floor. Running under these coolers are belt conveyors which receive the cooled clinker (drawn from four openings in each cooler) and carry it to the boot of an elevator, which discharges it through an opening in the wall between the kiln room and the clinker ball mill department onto a storage floor.

CLINKER BALL AND TUBE MILL ROOM.

As the clinker comes from the elevator spout it passes through a measuring device, in which is added the requisite percentage of gypsum (hydrous calcium sulphate). From the storage floor it is fed through hoppers into the Smidth ball mills, where the clinker is ground to pass a sieve having 20 meshes per lineal inch. It is then conveyed into hoppers, from which it is fed into Smidth tube mills, where it receives its final pulverization, at least 95% passing a No. 100 sieve.

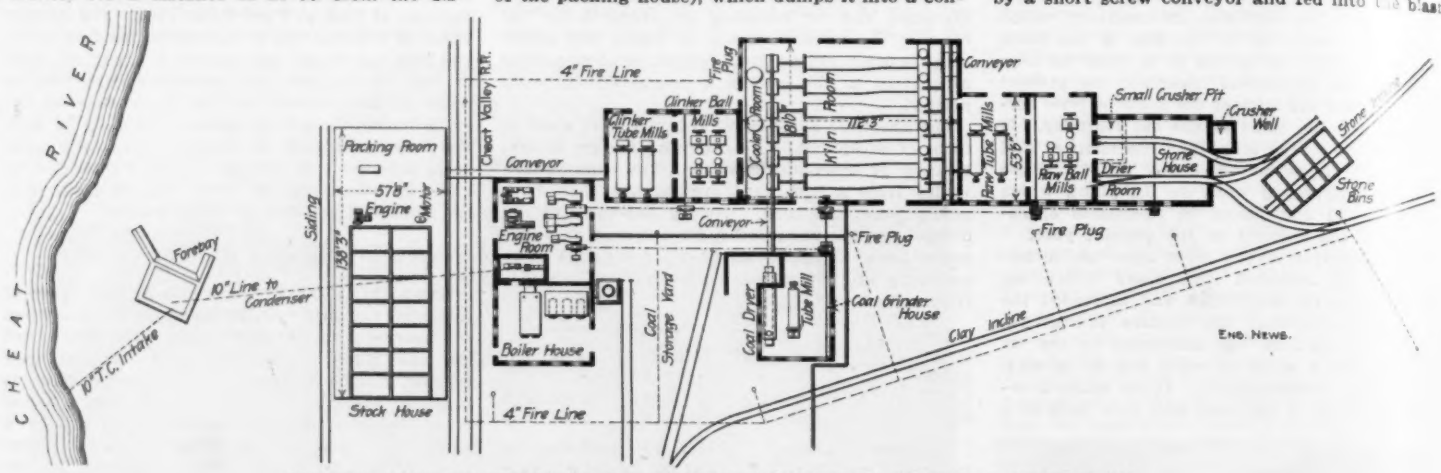
The cement is now ready for use, and is elevated and conveyed over the railway tracks into the stock house, where it is distributed into bins, from which it is packed (bagged or barreled) for shipment.

STOCK HOUSE.

The stock house consists of a packing department and 14 bins; the latter are 32 ft. high and are built of 2 × 6-in. lumber, laid flat and spiked every 18 ins.

The conveyor from the mill delivers the finished material into the boot of an elevator (in the center of the packing house), which dumps it into a conveyor running over the top of the bins, from which it is chuted into the bins. The machinery is driven from line shafting running through the center of the packing department. A 25-HP. steam engine and an electric motor of the same power are both belted to this shafting, thus avoiding stoppage through the disablement of either source of power.

The bins are built in a battery, seven on a side, along which is a 10-ft. passageway. There are two railroad sidings, one on either side of the stock house, and cars can be loaded from any bin, either directly from the bin or from the passageway.



GENERAL PLAN OF BUILDINGS AND PLANT OF BUCKHORN PORTLAND CEMENT CO.

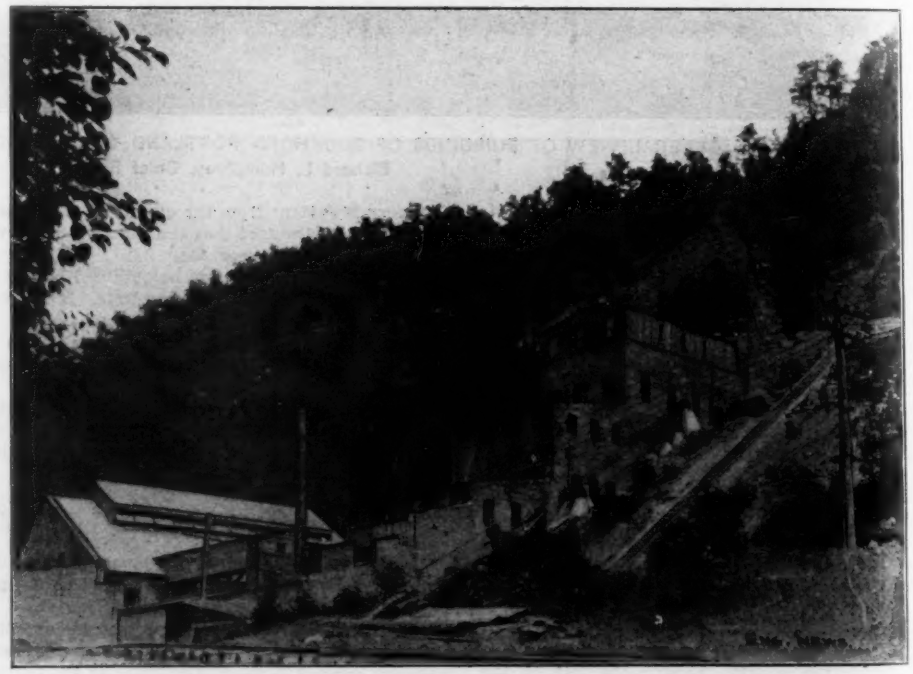
COAL HOUSE.

The raw material is burned or clinkered in the rotary kilns by a flame produced by a mixture of very finely pulverized gas coal and air. The coal for this purpose is run on a trestle in railroad cars and dumped on the ground below, from which it is wheeled or shoveled into a pair of rolls, which reduce it to about the size of coarse sand..

It is then elevated and fed through a hopper into a rotary dryer, built by Wm. F. Mosser & Son, where it is freed from moisture. The dried coal is next elevated into a hopper, from which it is fed into a Smidth tube mill, where it is reduced so that at least 95% will pass a No. 100 sieve. The pulverized coal is elevated and conveyed from the coal house through a covered passageway into the kiln room and delivered into the bins in front of the kilns, which each hold about an eight hours' supply.

The coal is drawn from the bottom of the bin by a short screw conveyor and fed into the blast pipe, which runs to the nozzle in front of the kiln. This screw conveyor is driven from a Reeves variable-speed countershaft, by which the coal feed can be regulated to suit conditions. Low-pressure air from Sturtevant blowers carries the coal through the blast pipe into the nozzle, from which it is blown into the kiln by a jet of compressed air. The low-pressure blowers are in duplicate, so that one can always be kept in service.

The coal thus thoroughly mixed with air, ignites as soon as it enters the kiln. The raw material coming from the opposite end is gradually heated, losing in turn its moisture and carbonic acid gas, and within 10 ft. of the discharge or front end of the kiln reaches a white heat, at which temperature it sinters, or just commences to fuse, forming clinker varying from the size of a pea to that of a walnut, with occasionally larger pieces. In this condition it falls from the kiln into the brick-lined chutes.



VIEW LOOKING UP MOUNTAIN SHOWING GRAVITY INCLINE RAILWAY.

POWER HOUSE.

The power house, consisting of a boiler and an engine room, is located, as will be seen from the

accompanying illustrations, at the bottom of the mill, from which the power is transmitted by means of manila rope drives up the mountain side to the various line shaftings.

The equipment consists of four water-tube boilers—one 250 HP. of the Heine type, built by the Kewanee Boiler Co., and three 150-HP. Kinney, internally-fired boilers. In addition to these there are being installed two 250-HP. boilers built by the Kewanee Boiler Co. The boilers are fed by two Snow pumps, and the feed water is heated by a Berryman heater. This is supplied with the exhaust steam from the feed pumps, fire pump and condenser, and the plant is so piped that the exhaust from the Buckeye engines, the air compressor and the electric lighting engine can also be utilized.

The steam is used in two Buckeye engines, one a 750-HP. compound, and the other a 250-HP. simple engine (the high-pressure half of a compound engine). Both engines are run at the same speed and have flywheels of the same diameter, grooved for rope transmission. The larger engine wheel contains 22 grooves, 18 of which are in use; while the smaller has 10 grooves, of which six are in use.

The engines run condensing, the exhaust being piped to a Deane condenser, located in a pit in one corner of the engine room, about 17 ft. below the floor. There is also a Barr 500-gallon underwriter's fire pump in this pit. Water for the boilers, fire pump and condenser is obtained from the Cheat River, about 175 ft. from the power house.

A Stillwell-Bierce & Smith-Vaile duplex steam, compound air compressor supplies the air for the operation of the drills at the quarry, and for the coal-burning apparatus in the kiln room. This machine delivers into a receiver outside the engine room, from which the air is carried in a 4-in pipe line to the quarry, an inch and a quarter line being tapped off to the kiln room.

The plant is lighted with incandescent and enclosed arc lights, the current being generated by a 75-KW. direct-connected General Electric Co. generator, and controlled from a two-panel marble switchboard. There is also a twelve-station intercommunicating telephone system, connecting the stock house, the quarry, the office and laboratory and the various departments of the mill proper.

VIEW IN CEMENT ROCK QUARRY.

POWER TRANSMISSION.

The transmission of power to the line shaftings is accomplished by means of seven manila rope drives, one of which is a single rope without any take-up; the remaining drives, consisting of several ropes each, are provided with tension carriages to automatically take up the slack and maintain a uniform tension on the ropes.

The 18 ropes driven by the compound engine are divided into two drives of seven and eleven ropes, the former transmitting power to the shafting, driving the clinker ball and tube-mill machinery; and the latter transmitting power for the operation of the raw material departments.

The six ropes from the simple engine drive the shafting running between the kiln room and coal house. The driven sheave being mounted on a quill provided with a clutch, makes it possible to throw the engine out of service whenever necessary.

Two eleven-rope sheaves, mounted on a quill provided with a clutch (through which the coal-house and kiln-room shafting runs) transmit the power to the upper portions of the mill. Ordinarily the kiln room and coal house are operated by the smaller engine, and the eleven-rope drive merely idles on this shafting. The system of quills and clutches makes it possible to operate these departments with either engine, the object being to ensure continuous service for the kiln room and coal house.

From the driving sheave the eleven ropes divide into an eight and a three-rope drive, the former transmitting power for the raw material ball and tube mills, and the latter for the stone house. From the shafting in the latter department, a single rope drive operates the belted hoist countershaft. On the inside of the kiln room a double rope drive transmits power to the front of the kiln room for the fans and clinker elevators.

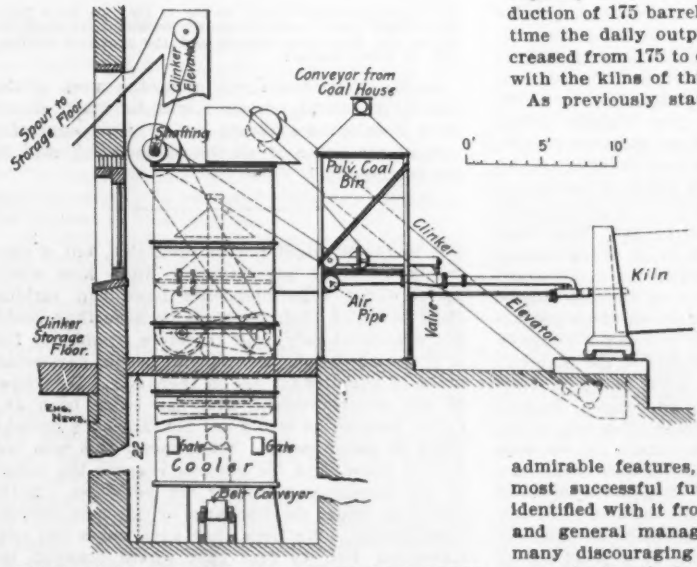


DIAGRAM SECTION OF COOLER IN KILN ROOM.

OFFICE AND LABORATORY.

This is a two-story frame building, on the lower floor of which is the office of the General Manager, the Superintendent, a general office and a drafting room. On the upper floor are the chemical and physical laboratories, a balance room, two experimental laboratories and a bath room. The equipment is such as is usual with a first-class building of this character.

ADVANTAGES OF LOCATION.

The plant is located at Manheim, W. Va., on the Cheat Valley R. R., which runs along the shore of the Cheat River and connects with the main line of the Baltimore & Ohio Railroad at a point one mile east of Rowlesburg, W. Va. From this point advantageous freight rates are in effect to Pittsburg, Cincinnati, Chicago, Baltimore, Washington and intermediate points.

The proximity of the plant to bituminous coal fields enables it to secure coal at very low rates. Low freight rates, cheap coal, a gravity feed from quarry to the stock house, and a deposit of raw material of exceptional quality are advantages which permit of the production of high-grade Portland cement at a minimum cost.

As to the quality of the cement being produced at the present time, no better evidence can be submitted than the following reports by well-known testing laboratories:

	Booth, Garrett & Blair.	Pittsburg Testing Laboratory.	Osborn Engineering Co.
Spec. gravity	3.08	3.08	3.18
Fineness.			
No. 100 sieve	99.3	95.5	99.9
No. 200 sieve	89.0	75.5	76.9
Time of Setting.			
Initial set	1 hr. 40 mins.	1 hr. 50 mins.	2 hrs. 35 mins.
Hard set	4 hrs. 15 mins.	3 hrs. 40 mins.	6 hrs. 50 mins.
Tensile Strength.			
Neat: 24 hrs.	422 lbs.	429 lbs.	406 lbs.
7 days	701 "	767 "	668 "
28 days	821 "	867 "	899 "
3 parts sand:			
7 days	299 "	262 "	217 "
28 days	456 "	307 "	415 "
Constancy of Volume.			
Steam			"O.K."
Boil'g water.		Satisfactory.	"O.K."
Cold water	Sound & hard.	Satisfactory.	"O.K."
Air	Sound & hard.		"O.K."
Chemical Analysis.			
Loss on ignition	0.90	0.76	0.96
$Si\ O_2$	23.72	22.56	22.72
$Al_2\ O_3$	6.85	8.83	10.54
$Fe_2\ O_3$	3.41	3.85	
Ca O	61.54	61.75	61.76
Mg O	1.44	1.56	1.78
So_3	1.72	....	1.75
Alkalies	....	....	0.49

The plant has been designed with a view to future extensions, and a glance at the general plan will show how readily the various buildings can be enlarged.

The plant was originally planned to have a capacity of 1,000 barrels per day, based on a production of 175 barrels per kiln per day; since that time the daily output of the rotary kiln has increased from 175 to over 200 barrels, as is the case with the kilns of this plant.

As previously stated, lack of sufficient capital delayed the completion, and in resuming work the main object was to place the plant in operation as quickly as possible in order to demonstrate the practicability of the enterprise.

This vital point having been satisfactorily settled, the company will now install the boilers and grinding machines necessary to develop the full capacity—about 1,300 barrels per day.

The plant is substantially built, possesses many admirable features, and has every promise of a most successful future. The writer has been identified with it from its inception as its engineer and general manager, and, notwithstanding the many discouraging and adverse reports on the property (particularly as regards the quality and availability of the raw material), has always been confident of its ultimate success, and, having achieved his purpose in the completion and successful operation of the plant, he resumes the practice of a consulting engineer.

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It is a singular coincidence that within a single month there occurred three different accidents to steel frame structures in course of erection: the traveler accident on the Wabash bridge in Pittsburg, the fall of part of the steel work of a mill building in Chicago, and the blowing down of several bents of column-and-beam work for a warehouse in New York. Accidents to bridges or buildings during erection are not common. In the present case the fact that three such accidents occurred within a single month is the more striking because each of the principal types of steel construction is represented: the bridge, the tier building and the mill building. The Wabash bridge accident, the most serious of the three as regards loss of life, probably falls in that class of unpreventable accidents where an insecure temporary fastening is knocked loose, or a rope or other part of the rigging slips or breaks. The other two accidents, however, seem to be chargeable to a more direct cause, the very common disregard for proper lateral bracing during the erection of building framework. Such work is often put up with prime regard for speed of erection; loosely bolted connections and the inertia of the material are relied upon to hold the work in place, even with the riveting several stories behind. In mill building work the side bracing is often left to the last, or, where curtain walls constitute the sole bracing, the masonry is started only after the steel work is all in place. Diagonal shores or temporary rods take time to put in, and often the erector takes the chance of accident in order to hurry his work to completion. If a wind storm occurs, or if by carelessness a guy or a hoisting rope is fastened to the steel work, an accident results. However, as already stated, accidents of this kind are extremely rare, and the fact that we have to report two within less than a month remains an unusual coincidence.

An important result of the Berlin-Zossen high-speed electric railway experiments is the proof that it is practicable to take current from overhead conductor wires at speeds approximating 125-130 miles per hour, that is, about 200 ft. per second. The value of this result lies in the fact that expectations regarding the electric working of main-line railways are mainly based on the direct utilization of alternating current at relatively high tension, and that for such service it becomes out of the question to employ conductors at or near the ground like the third rail, the present standard for interurban electric railway working. The successful results at Berlin are chargeable largely to the well-devised construction of the overhead line and the collectors. In particular, the flexible or elastic suspension of the conductors appears to be an essential factor. It may be noted that the principle of elastic suspension has been recognized in the overhead line construction of some electric roads built for only the ordinary commercial speeds; a good example is the Union Traction Co., of Indiana, whose line was described in our issue of Nov. 13, 1902.

Unique among technical educational institutions is the Correspondence School of the American Gas Light Association. A brief but excellent critical summary of its work was presented at the recent meeting of the association by Mr. Alex. C. Humphreys, President of Stevens Institute of Technology, and a gas engineer of international repute. President Humphreys' paper was all the more valuable because of his recent experience as the head of a great technical school.

The Correspondence School of the American Gas Light Association is supported wholly by private subscriptions, is managed by trustees, but is under the direct charge of Mr. Alfred Forstall, Secretary of the Association. A high tribute to Mr. Forstall's work was paid by Mr. Humphreys. The school originated about eight years ago. The annual expense of conducting it is about $4,000, or some $40 per student. This low figure Mr. Humphrey compares with the $150 tuition and the $250 of actual cost per student at the Stevens Institute of Technology. Of course "the two schemes of education," as Mr. Humphreys states, cannot be fairly compared, but it is fair to show the relatively small cost of the Correspondence School. A partial offset to the acknowledged limitations of correspondence as compared with regular technical schools is the fact that the students

> of a correspondence school, as far as they go, have fuller opportunity than do the college students to carry along together the theoretical studies and the practical application of those studies.

As Mr. Humphreys well says, the work of the regular technical schools might be much shortened if only the students had a "keen appreciation of the value of all the subjects included in the curriculum."

It might or might not be profitable, but it certainly would be interesting, to know how many water-works superintendents have run serious risks of losing their positions because they could not conscientiously, and therefore would not for any consideration, recommend some particular make of supplies for use in their city. We know of one superintendent who has twice been assailed because he would not recommend a certain make of water meter. What meter this was we do not know, and for obvious reasons the name of the superintendent will not be given. Both efforts to secure the discharge of this man proved unsuccessful. We hope that such cases are not numerous, but we fear that where coaxing, to put it mildly, will not work, attempts at coercion of one kind or another are frequent. Such a policy is likely to prove short-sighted in the long run.

It has been stated that on certain roads in France an increased wear has been noted since the introduction of the automobile. The cause of this wear has not been ascertained, and it may be due to the heavier wheel loading of the slow-speed freight vehicles rather than the light and fast moving passenger cars. The question has been raised, however, whether the pneumatic tires of a rapidly moving automobile may not be injurious to macadam. The backward push of the propelling wheels, it has been urged, may loosen the surface stones and cause raveling of the macadam. Much reliance cannot be placed in this theory, but there is certainly one feature about the action of automobiles on macadam roads that deserves serious consideration—that is the dust feature. An automobile moving at high sped over macadam that has not been recently sprinkled, throws up a cloud of dust very much like that from a passenger train on a dirt ballasted railway track. In either case the passengers escape the greater part of the dust thus raised, but not so the pedestrian, or the traveler in a slower-going vehicle. More than this, the dust so raised is blown into the houses of those living near the road, and is not only disagreeable, but may be injurious to health.

How may this condition best be met? One obvious solution of the problem would be frequent sprinking of the roads, but this is too expensive to be practicable outside of city streets. The better solution will undoubtedly be to limit more rigidly the speeds of vehicles riding on the common roads, and there will be little difficulty in doing this as soon as the present day fad for high speed automobile running goes out of fashion.

There may, however, be some demand in the future for special roads suitable for the use of pleasure automobiles on which higher speeds will be permissible than are allowed on the ordinary highways; and to make such roads as free as possible from dust will be a distinct advantage. It will be a help, doubtless, to use only stone screenings as a binder, and with only rubber tires running on such a road it might pack down hard and make very little dust. Such a road would probably be the least slippery in wet weather of any that could be built. Sprinkling with oil might help to keep down the dust; but such sprinkling would have to be done with the greatest care, since any excess of oil would be destructive to the rubber tires. Perhaps bituminous macadam might prove satisfactory for such a road, but here again care would have to be taken to keep down the proportion of bitumen and make the surface of the road rough enough to give the tires a good grip.

The brief article in this issue by Dr. Perrine on water power development in New England presents a very interesting illustration of the force of precedent and custom in engineering design. It would not be too much to say that water power development in the East still follows the customs established by early New England millwrights. The mill dam, the mill pond, the fore-bay and the turbine are so common that they are deemed essential parts, and the possibility of utilizing high heads by an installation which discards these familiar elements and substitutes the diversion weir, the canal, and pipe line and the impulse wheel is entirely unrecognized.

THE LATEST GARBAGE DISPOSAL STATISTICS.

The most recent illustration of the unsatisfactory condition of garbage disposal in this country is afforded by a paper presented at the meeting of the American Public Health Association at Washington on Oct. 28. We refer to the paper entitled "Some Statistics of Garbage Disposal for the Larger American Cities in 1902," by C.-E. A. Winslow and P. Hansen, of the Biological Laboratories of the Massachusetts Institute of Technology. The authors deserve commendation for their persistent attempts "to collect a certain amount of first-hand information as to the condition of garbage disposal practice in the United States in the year 1902." The statistics show that most cities are still employing primitive means of garbage disposal, or even neglect-

ing the service altogether, and emphasize anew the lack of accurate comparable figures from cities where any method whatever has been adopted. The authors fail to state any sanitary principles to serve as a standard for judging their conclusions, but the conclusions themselves indicate that the authors have taken too seriously some of the popular ideas on the sanitary aspects of garbage disposal.

The paper is accompanied by a large table giving more or less complete returns from 155 of the 161 cities having populations of 25,000 and over. Of the 155 cities, 29 stated that their garbage was not collected regularly, but 148 reported some method of collection.

Of these 148 the work was performed by the city in 54 instances, by contract in 49, by private parties in 37, and by a combination of two of these methods in 8 cases. These figures have been made up by us from the main table submitted with the paper. In the original the summaries are by methods instead of cities, thus resulting in duplications. Of the combination cities the municipality does some of the work in 7 out of 8 cases, including New York, where all the garbage of Manhattan borough is collected by the Department of Street Cleaning. On the face of the returns this is a better showing than might have been expected, but the totals in the various classes tell very little without being weighted by the character of the service. What percentage of the population is served under each method of collection, and how often are the collections made? More than half the cities reporting no regular system of collection give a method of collection, thus indicating that while irregularly done the garbage is sometimes gathered. It is very likely that some of the 29 places reporting no regular collections have at least as good service as some of those reporting the work done by private parties or by the city. Where the work is done by public contract something definite is almost always specified, be it little or much, but it is a notorious fact that garbage contractors are often left to follow the devices of their own hearts or the dictates of their consciences, neither of which can be implicity relied upon. Collections by the city are often limited in both area and portion of the year covered, while the collections reported as private are made only where and when paid for by individual householders. While only eight cities report a combination of two methods of collection, it is doubtless true that the same condition exists in many of the other cities. The most that can be said for a certainty, without taking the cities up in detail, is that 111 of the 148 cities reporting on the subject have adopted the principle, but to what degree is unknown, that garbage collection is a municipal responsibility, whether done by day labor or by city contract.

The next notable feature of the statistics relates to the separation of garbage, ashes, and combustible wastes. The returns on this subject are not summarized, further than the statement:

> Out of 146 municipalities, 111 report a more or less complete separation of waste materials, the garbage in particular being commonly kept distinct from ashes and combustible wastes. In contrast with European practice this tendency is marked.

Running through the table accompanying the paper, we find that the foregoing figures may be revised and supplemented by saying that, on the face of the tabulated returns, 44 cities separate the refuse collected into garbage, ashes, and combustible refuse; 53 separate garbage only; 5 separate ashes, 1 separates combustible waste, 4 collected nothing but garbage, and 36 have no separation whatever. Doubtless these figures, like those for methods of collection, are far from accurate, it being very probable that in some of the cities reporting three separations, as well as in some of those reporting no separations, that garbage alone is systematically collected. But unquestionably more or less well separated garbage is to be found in the majority of the cities taken into consideration. This is particularly true because of the fact that in America, especially in all but the larger cities, garbage is the most troublesome material of the three, and the first to become a matter of public concern. Ashes, almost without exception, are gotten rid of by dumping, but the San Francisco report states that they are cremated. Combustible waste is generally dumped, also, in which case it is frequently burned (in the open air.—Ed.). In 19 cases the reports state that combustible wastes are, to quote from the paper, "cremated or utilized." Utilization is practiced at Boston and New York only, where a portion of these wastes is picked out and marketed as old paper, junk, etc.

Coming to the final disposal of the garbage, the paper gives the following summary of methods, noting that in many cities more than one method is in use:

Dumping on land	44
Burning on dump	9
Dumping in water	14
Plowing in or using as fertilizer	18
Feeding to live stock	41
Cremation	27
Reduction or utilization	19
Irregular disposal by private parties	11

This makes a total of 183 methods, in 156 cities. Dumping on land the authors consider less satisfactory than feeding to stock, partly because the latter tends to ensure a more frequent collection and a more speedy and complete disposal. A number of cities are named where feeding to stock yields a revenue, either directly or through a contractor.

Arguments in favor of feeding garbage to stock seem strange in these days, but for the present we can only say that the practice was strongly defended by Dr. Chapin, of Providence, R. I., in a paper read before the American Public Health Association last year and published in the last volume of Proceedings.

The authors of the present paper regard either cremation or reduction as the only scientific methods of disposal now employed, and of the two they much prefer cremation. They do not attempt to support their preference by detailed arguments, and we cannot but feel that such arguments as they do advance are based on superficial reasons and to some extent on the prejudices of other writers. For instance, they assume that where garbage is burned it can be dumped into the furnaces without storage, whereas in reduction works the garbage must be stored and offense arise on that account. As a matter of fact there is more or less storage in either case, but it is possible with either process to reduce this to a minimum by providing extra furnaces or digestors, respectively; or the storage, in either case, may be in air-tight receptacles.

Figures of cost of cremation and reduction are presented, but confessedly they are likely to be misleading if used for comparative purposes. The authors, however, do not go far enough in showing how misleading the figures may be. Taken at face value, cremation has ranged in cost from $2.19 to $0.25 per ton, but the figures cited at each extreme (Lowell, Mass., and Allegheny, Pa.) are now some three to five years old, and neither of the furnaces in question are now in use; or the Allegheny furnace is abandoned and the one at Lowell is run irregularly, if at all. Omitting extremes, the authors give $0.50 to $1.00 per ton as the cost of cremation with an average of "perhaps $0.85," but they add that "these figures probably in no case include any allowance for interest or sinking fund."

The cost of reduction is cited or estimated for only seven cities, as compared with 21 in the case of cremation. For these seven the figures range from $2.16 (quite old) at Syracuse, to $0.44 at Buffalo. These figures, since they are in every case payments to private companies, may be assumed to include not only interest and sinking fund, but heavy depreciation and varying rates of profit as well. But the actual facts are not available, since they are closely guarded trade secrets. All the furnaces, save one or two, are owned and operated by cities, and the garbage is delivered at the tops of the furnaces, or even dumped on the fire, by the collecting wagons. Some of the companies operating reduction works transport the garbage long distances by rail or water. Moreover, where reduction is practiced the material treated is more likely to be exclusively garbage than is the case with furnaces, since combustible wastes are welcomed at the latter. These and other reasons make cost comparisons very uncertain, which has been partially, but not sufficiently, recognized by the authors. They finally sum up the economic phases of the two systems by saying that they "are fairly well balanced as far as the municipality is concerned, the advantage, if any exists, being on the side of cremation." The authors then cite "subsidiary considerations" which "militate against the success of the reduction system." Some of these "limitations" are corrupting bargaining in the case of contracts for reduction, "absent from the simple maintenance of a public cremator;" dangers of breakdown; instability of the market for grease and fertilizing material, and sweeping charges as to "offensive odors" being "an inseparable concomitant of the utilization process," followed by the declaration that "it is unnecessary to cite examples of the endless trouble these processes have caused to boards of health." As a clincher of this sanitary condemnation of reduction, two men are quoted, one of whom has long been commercially interested in garbage furnaces, while the other is strongly prejudiced against reduction.

The authors next declare that probably

> the larger American cities have so far pursued a mistaken policy, and in the adoption of the reduction system have sacrificed the comfort of a portion of the community for no adequate economic return, since it is certain that a cremator in which garbage is dumped straight from the carts and whose flue gases are properly treated may be wholly free from nuisance.

Such a statement must at best be largely a matter of personal opinion. The same is also largely true of the first two of the propositions laid down in the closing sentence of the paper:

> The experience of the last few years has only confirmed the conclusions of the Committee on the Disposal of Garbage and Refuse* that separation of waste materials is neither economical nor desirable, that the cremation of mixed refuse appears to be the most generally satisfactory process, and that this cremation may be best accomplished in furnaces of the English type.

On the first two propositions, Mr. Rudolph Hering, M. Am. Soc. C. E., for many years chairman of the committee named, said less than a month ago at the Baltimore convention of the League of American Municipalities (Eng. News, Aug. 15, 1903) that the local conditions must determine in each case whether one general collection or separate collection is preferable, and also whether cremation or reduction should be adopted. He also said, in effect, that there is no reason why reduction works cannot be operated in a perfectly sanitary manner.

Finally, we wish to express our growing belief that the whole garbage disposal problem has been and is largely still being approached altogether too much from the viewpoint of odors and sentiment and too little from that of modern sanitary science. Our present ideas were, in the main, so well expressed a year ago† by Dr. Charles V. Chapin, Health Officer of Providence, R. I., and author of "Municipal Sanitation in the United States," that we will close by quoting from his paper:

> We have been so long told that filth and foul odors are the cause of sickness that it seems to be very hard for the public, and even alleged sanitarians, to give up the idea. Because garbage smells bad, and hog pens smell bad, they are supposed to be unwholesome. This is pure fiction. There is no reason whatever to suppose that sickness ever comes from such causes. It makes no difference to the health of the town how its garbage is disposed of, or how it is collected, or in fact whether it is collected at all. It is not a question of health, but one of comfort. Garbage removal is work not for the department of health, but for the department of public works. What is needed is the advice of engineers, not of medical men. Garbage should be collected with the least possible nuisance and disposed of with the least possible nuisance. But it should also be done with some regard for economy. It would, in Providence, cost many thousands of dollars more each year to dispose of garbage in any other way than by feeding to swine, and there is no reason to believe the method would be any more satisfactory to the citizens, and would certainly have no effect upon the public health. It would be worse than folly for that city to spend money for the cremation of garbage, when there is such urgent need of funds to properly care for smallpox, scarlet fever, diphtheria and tuburculosis.

*Trans. Am. Public Health Assoc., 1897.

†Trans. Am. Public Health Assoc., 1902.

LETTERS TO THE EDITOR.

The New York Barge Canal.

Sir: In regard to the replies of engineers to your circular letter concerning the New York State barge canal, in your issue of Oct. 22, I think Major Bixby has concisely defined the situation. A barge canal with transhipment at Buffalo would cost more than it is worth. We have 2,000-ton boats which are running through to tidewater in preference to connecting at Port Colbourne with 6,000 and 7,000-ton steamers on the upper lakes.

Very truly yours,
Thos. C. Keefer, M. Am. Soc. C. E.

Ottawa, Ont., Canada, Oct. 29, 1903.

Are Y's Ordinarily Included in the Linear Measurement of Sewer Pipe.

Sir: Referring to the article under the above title in your issue of Oct. 15, will say that a careful study of many bids published in the engineering papers for several years has failed to disclose any universal custom in paying for Y's. Many sewers are constructed for a lump sum, so that a measurement is not necessary. It is my opinion, however, that when the work is bid upon in units, the prices are, as they should be, for the Y's as extras and not to be deducted from the price for the straight pipe.

It has been my practice to let the work for a lump sum and if extra Y's were furnished, they were paid for slightly above the cost price. Very truly,

W. G. Kirchoffer, Consult. Engr.

Baraboo, Wis., Oct, 28, 1903.

Centrifugal Pumps Under Constant Head with Variable Speed.

Sir: In your issue of Oct. 1, p. 303, is an editorial note on my article on "Electric Motors for Centrifugal Pumps and Fans," wherein you state that under Case 3, "If the head remains constant, the preceding statement is not true for pressures and watts."

As previously stated in the article, all curves for fans are based on an absolutely fixed speed. That is to say, any change of speed will necessitate an entirely new set of curves. This set can be obtained from a known set, in the manner indicated, when the ratio of speeds alone is known. Thus if the speed be altered to a new given value, points in Cases 2 and 3 will lie on the same set of curves—but will be differently situated. To each point on the curves, at one speed, will correspond one, and only one point at another speed, independent of the design of the fan.

Let (Q_1, P_1) represent a point on the pressure curve at speed S. Let the speed be altered to K S. The corresponding point on the new speed curve will be ($K\ Q_1$, $K^2\ P_1$). From this point (P_1, Q_1) alone, it is impossible to find a corresponding point (P_1, Q_2), for the new speed. This point will have to be obtained from another point (P_2, Q_2) on the first curve, where $P_2 = \frac{P_1}{K^2}$. Then the corresponding point on the curve at speed K S, will be ($P_2\ K^2$, $Q_2\ K$), or ($P_1\ Q_2$).

A similar treatment will follow for the other curves.

Yours truly, Aug. J. Bowie, Jr.

899 Pine St., San Francisco, Cal., Oct. 16, 1903.

Further Facts Relating to the Riveted Steel Conduit at Atlantic City, N. J.

Sir: I note the reply of Mr. Kenneth Allen, on p. 376 of Engineering News for Oct. 22, to your inquiry regarding the choice of wooden stave pipe for the new conduit of the Water Department of Atlantic City, instead of riveted steel pipe which was used for the force main in 1901.

Mr. Allen's reply covered the ground as far as he went, but regard for propriety has evidently led him to omit a very important factor in the choice of the material for the conduit.

Since the award of the contract for the riveted steel force main by the city council of Atlantic City, against the advice and recommendation of both the consulting engineer and the engineer of the water department, the city of Atlantic City has adopted a new charter, by which the business of the water department, including the letting of contracts, is placed in the hands of three water commissioners, without any assistance (?) from city council, except to make the necessary appropriations. The Board of Water Commissioners is a non-partisan body, one member being appointed by the Mayor each year, subject to confirmation by the city council, and is composed at present of three well-known business men. "Nuf ced."

That the life of the steel main would be short—ten or fifteen years—was fully expected when it was laid. Since council had barred wood stave pipe, the choice lay between steel and cast-iron, and the experience with the old cast-iron main (laid beside railroad tracks in a marsh with no solid bottom) and the subsequent experience in placing the special castings in the line of the steel main, have amply justified the choice of steel.

There is a matter of interest regarding the burlap covering of the steel pipe. It was used with the idea that it would protect the asphalt coating on the steel while the pipe was being transported and handled. This it did. It was expected that the burlap would rot soon after being covered in the marsh, but it has shown little if any sign of rotting up to the present time. The result is, that if dogs, hunting for mice in the sods covering the pipes, or high tides tear the sods off of the pipe, the burlap frequently is pulled off too and the mineral rubber coating is pulled off the steel pipe with it.

Very truly yours, W. C. Hawley,
Gen. Supt. Pa. Water Co.

Wilkinsburg, Pa., Oct. 24, 1903.

Making Photo-Copies from Blue Prints.

Sir: Your correspondents seem to have omitted the particular procedures that are essential in producing a good photo-copy from a blue print.

I enclose photo-copies made from an ordinary blue-print, on thick paper, and you can judge as to their excellence.

The method is as follows: Convert the blue print into a brown print by the toning method mentioned by Mr. Bartels (Engineering News, Oct. 29). Observe particularly that the tannic acid solution must be kept from contact with metal and it must not be overworked, or else the lines will be made brown. The brown print, unlike the blue, is not susceptible to alkaline solutions, but the brown color may be discharged with acid.

Next the print must be rendered translucent, for this purpose a hot flatiron may be used on which paraffine is rubbed occasionally. Continue the process until the print appears uniformly translucent. This is an easy and quick process. Probably a solution of paraffine in benzine would be as efficient as the melting of the paraffine with a hot iron.

Using the translucent brown-print, make a photo-copy precisely as a copy would be made from a tracing. Brown print paper gives the best copies though very fair copies may be made, and more quickly, from rapid printing blueprint paper.

The blue-print may be paraffined without first converting it into a brown print, and then used to make brown or blue prints from, with results that may often prove acceptable.

Very truly yours, Horace Andrews.

51 State St., Albany, N. Y., Oct. 30, 1903.

[The samples enclosed by our correspondent are all very good reproductions, but the translucent brown-print, made as described, gives much the better print either on brown or on blue print paper.—Ed.]

The Shading of Cylinders.

Sir: Permit me to call attention to what seems to me to be an error in the shading of the convex semi-cylinder shown in your issue of Oct. 15. Assuming that the rule for shading a projecting semi-cylinder is the same as for a full cylinder, then when the light comes from the left, as it does in your figure, the heavy line on the right, when the cylinder intersects the plane, is incorrect. It should be very light; the heaviest lines should be not quite half way up the right-hand half of the cylinder, and shaded off, lighter and lighter, both ways. This gives an unmistakable effect of convexity, which your left-hand lower figure lacks. Your figure represents rather a concave surface, with the light coming from the right. All the other figures are correct. G.

New York, Oct. 16, 1903.

(Our correspondent is correct, according to the practice laid down in many books on mechanical drawing and followed by many mechanical draftsmen, particularly in Europe; and it is not to be denied that a cylinder elevation on which the heaviest shade line is placed, not at the extreme right, but at the point stated by our correspondent, will most closely represent the effect of light and shade on an actual cylinder, provided the light is supposed to come from the conventional source and provided also that some reflecting surface is placed opposite the right-hand side of the cylinder.

The advantage of the practice which we have adopted is that it harmonizes with the practice of using shade lines on drawings. It is, of course, the exception to shade rounded surfaces on a mechanical drawing; but the use of shade lines is very common. If after the shade lines have been placed on a drawing, it is desired to shade some of the rounded surfaces, it can readily be done by our method, while to follow the method of our correspondent would place two heavy lines on the cylinder elevation, one the shade line at the extreme right and the other the shade line some distance to the left, with lighter shading between. Such a drawing is incorrect and confusing to the eye. The method we have adopted, moreover, has the further advantage that comparatively few shade lines are necessary to produce the cylindrical appearance.—Ed.).

Which is the Most Effective: A Long-Handled or a Short-Handled Shovel?

Sir: Are there any published data relative to the use of long-handled shovels, as compared with short-handled?

In the West (Pacific Coast states) short-handled shovels are seldom used on construction work. In the Eastern and Middle states the short-handled shovel is more common. Many employers of labor prefer the short-handled shovel, but the men take long-handled shovels usually in preference when a choice is given.

In the writer's experience, the long-handled shovel is preferable where there is both a lift and a throw. Where there is simply shovelling and casting on about a level the short-handled shovel seems best. For this reason he gives men in a trench long-handled shovels and those who cast back from the banks short-handled shovels. Where there is digging and lifting, the long handles seem best. Where there is digging and casting, without any particular lift, what little difference there is seems to be in favor of long handles.

The ease of working with long-handled shovels is so great as compared with short handles, that the writer generally permits the laborers to make a choice. When new to the work he gives them the long shovels.

An argument has arisen on this point lately. Perhaps readers of your paper can give the benefit of their experience.

Yours truly,
Ernest McCullough.

Chicago, Ill., Oct. 28, 1903.

(We can find no published records of comparative output of men using shovels with handles differing in length. There is one feature of the short-handled shovel worthy of notice. The man using a short-handled shovel can, and usually does, press with his knee against his right hand in forcing the shovel into the earth. His right hand grasps the U-shaped handle and in consequence of this and of the help received from his right leg he is less apt to tire that arm, and can easily force the shovel against considerable resistance. On the other hand, the long-handled shovel appears preferable for casting out of a trench, once it has been loaded. As our correspondent says, the long-handled shovel is preferred in the West, and the short-handled shovel in the East for trench work and wagon loading.

The preference for one or the other may after all be a matter of training, and in this respect the controversy would resemble the war of words once waged as to whether a light 5-lb. hammer or a heavy 9-lb. hammer is more effective in single-hand drilling.—Ed.)

THE DETERMINATION OF THE LONGITUDE OF HONOLULU, 1555-1903.

By John F. Hayford,* Assoc. M. Am. Soc. C. E.

The occasion for this article is the recent determination by the telegraphic method of the difference of longitude of San Francisco and Honolulu through the new Pacific cable by Messrs. Edwin Smith and Fremont Morse, of the United States Coast and Geodetic Survey.

The first signals over this portion of the cable were sent on Jan. 1, 1903. The cable was opened for public use on Jan. 5, 1903. The first observations in the telegraphic determinations of longitude were secured on April 20. The cable company coöperated with the government by aiding the observers in various ways, and by granting the free use of the cable during a short period each night for their work.

Between April 20 and June 13 eleven determinations of the difference of longitude were made, five with the observers in one position and six after they had exchanged places for the purpose of eliminating the effects of their relative personal equation. The total range of the eleven results was only 0.17 s. No result differed from the mean by as much as one-tenth of a second.

This degree of accuracy corresponds to that usually attained in determinations of the difference of longitude of two places connected by a telegraph line over land. Until within a few years such a degree of accuracy has not been possible

*Chief of Computing Division, U. S. Coast and Geodetic Survey, Washington, D. C.

for determinations made through long cables. The increase in accuracy has apparently been due to improvements made in the recording apparatus used by the cable companies.

The difference of longitude of the transit piers in San Francisco and Honolulu, respectively, was found to be, from the field computation, 2 h. 21 m. 38.92 s. A revision of the computation still remains to be made, but the changes in this result will be very small. The chances are even for and against the difference stated, being within 0.03 s. of the truth.

The longitude of San Francisco from Greenwich is fixed by four transatlantic determinations by the telegraphic method, 1866, 1870, 1872 and 1892, and by a complicated telegraphic longitude net stretched across the United States.

The longitude of the Transit of Venus pier at Honolulu, as fixed by the new determination from San Francisco, is 10 h. 31 m. 27.24 s. west of Greenwich. Taking into account all the uncertainties in the chain of observations between Greenwich and Honolulu, the chances are even that the value stated is correct within 0.06 s., and it is almost certain that it is not in error by as much as 0.2 s. In the latitude of Honolulu 0.06 s. of longitude corresponds to 85 ft., or 1 s. to 1,418 ft.

The observers, Messrs. Smith and Morse, are still engaged in determining the differences of longitude over the three other spans of the cable between Honolulu and Manila. A good determination of the difference Manila-Guam has already been secured. When their work is complete the longitude of Manila will have been determined telegraphically in both directions around the world from Greenwich, and the longitude girdle of the earth will be complete.

The following resumé of various determinations of the longitude of Honolulu is condensed from an account furnished by Mr. W. D. Alexander, formerly Surveyor General of the Hawaiian Islands, and now an Assistant in the Coast and Geodetic Survey. It is especially interesting as showing a comparison of various determinations of a large difference of longitude by a variety of methods and extending over three and a-half centuries.

In the accompanying tabular statement the new determination of the longitude of the Transit of Venus station, 10 h. 31 m. 27.2 s., is taken as being correct in deriving the errors of the various determinations. In cases in which older determinations referred to some other point than the Transit of Venus station, they have been reduced to that station by using the relations in position which are now known.

Determination of the Longitude of Honolulu.

	Longitude of Transit of Venus pier Honolulu h. m. s.	Error of Longitude.
John Gaetano, 1555, no chronometers, no log	9 23	—68m.
Cook, 1785, observatory on Hawaii	10 31 45	+18s.
Vancouver, 1790, based on Cook, various points	45 to 27s.	+18 to 0
Freycinet, 1819	26	—1
Wilkes, 1840, based on Cook	35	+8
Lyman, 1845-1846, moon culminations, predicted places	15	—12
Fleurials, 1868, 27 moon culminations, first computation	21.8	—5.4
Fleurials, 1868, second computation	25.9	—1.3
Tupman, 1874, 700 culminations, 13 occulations, 540 zenith distances of moon, first computation	15	—12
Tupman, 1874, second computation	27.2	0.0
Tupman, 1874, combined with first computation of Fleurials	26.3	—0.9
Tupman, 1874, combined with second computation of Fleurials	26.7	—0.5
Tupman, 1875, 20 chronometers, one trip, Honolulu to San Francisco	33.2	+6.0
Hawaiian Government Survey, 1884, chronometers, 2 round trips, Honolulu to San Francisco	25.8	—1.4
Hawaiian Government, adopted in furnishing time	26.0	—1.2
Hawaiian Government, adopted for mapping purposes	27.2	0.0

In the Spanish chart found by Lord Anson on board the Galleon, which he captured in 1743, a group of islands was laid down in the same latitude as the Hawaiian Islands, but 17° too far east. The southernmost and largest island its high table land. North of it were La Desgraciada, probably Maui; and three small islands called Los Monjes, was named La Mesa, which seems to refer to Hawaii with which may have been Kahoolawe, Lanai and Molokai. This chart was published in the narrative of Lord Anson's voyage in 1749.

An official letter from the Spanish Hydrographical Department to the Hawaiian Government, dated Madrid, Feb. 21, 1865, states that an ancient manuscript chart exists in the archives of that office, in which this group is laid down as in the chart of the Spanish Galleon, with the name "Islas de Mesa," and a note declaring that they were discovered and named by Juan Gaetano in 1555.

The large error in the longitude of La Mesa, of 17°, more than 1,000 nautical miles, is not surprising when it is considered that chronometers were not yet dreamed of, that the Spanish navigators depended entirely on dead reckoning for their longitudes, that the use of the log for measuring the velocity of a ship was not known before 1607, and that the equatorial current would be effective in producing an error of the sign actually found. Thus La Pérouse, coming from California, found that the error in his dead reckoning caused by this current, when he arrived off Hawaii, amounted to 5° to the east, and Vancouver coming from the south, found a similar error from the same cause, amounting to 5° 14′.

When Capt. Cook discovered Hawaii, in 1768, he was not aware that he had accidentally rediscovered La Mesa, and his successors at first retained both La Mesa and the Sandwich Islands on their charts, as may be seen in the atlas accompanying the early editions of Cook's Voyages.

Seven years later, in 1785, two of Cook's officers, Portlock and Dixon, on their way to the northwest coast, as their crews were suffering from scurvy, headed their ships for the supposed position of La Mesa, sailed over it, and ran down the parallel of latitude till they arrived at Hawaii. A few days later La Perouse, after searching in vain for La Mesa, did the same, and became convinced of its identity with Hawaii.

The charts attached to the early editions of Cook's Voyages placed Kealakekua Bay at 156° 00′, or 18 s. too far west.

Although chronometers were put into use prior to 1714, as late as 1762 John Harrison won a reward of £20,000 from the British Government for having constructed a chronometer which, according to the test made, determined the difference of longitude of Portsmouth, England, and Jamaica within 18 miles. The prize in question was offered in 1714, and it took 47 years to make sufficient improvements in chronometers to win it. Capt. Cook's error of only 18 s., or four and one-half miles, in the longitude of Honolulu was, therefore, remarkably small for that time.

Capt. Vancouver, in 1790, adopted the same longitude of Kealakekua as Capt. Cook, viz.: 156° 00′. The true longitude of Cook's observatory there is about 155° 55′ 30″. Vancouver gives for the longitude of his anchorage off Waikiki, Oahu, 157° 50′ 23″ W., which is only half a mile too far west, and for Waimea, Kauai, 159° 40′ W., which is probably within a quarter of a mile of the true longitude.

Capt. Freycinet, of the scientific exploring ship "L'Uranie," in 1819, made the longitude of Kealakekua 156° 04′ 23.5″ W. from Greenwich, which is 36 s. too far west. He made the longitude of Honolulu 157° 51′ 46.2″ W. from Greenwich, which is about 1 s. too far east.

Com. Chas. Wilkes, of the U. S. exploring expedition, in 1840, adopted Capt. Cook's longitude of Kealakekua Bay, viz.: 156° 00′ W., and placed Honolulu at 157° 54′ W., and Waimea, Kauai, at 159° 44′ 30″, both of them 8 s. too far west.

During the years 1845-6 the late Prof. Chester S. Lyman, afterwards a professor at Yale University, who was then residing in Honolulu for his health, assisted Mr. David Flitner, chronometer maker, in establishing a small observatory here, and made a series of meridional observations of the moon, in order to determine the longitude. The result he obtained, using the predicted places of the moon in the American Ephemeris, was 10 h. 37 m. 15 s. W., or 12 s. too far east.

In the year 1868, M. Fleurials, in the service of the "Bureau des Longitudes," who came to observe a transit of Mercury at Honolulu, established an observatory near the Catholic Cathedral, where he observed 19 meridional transits of the moon's first limb, and 8 of the second limb. These observations are published in detail in the appendix of Connaissance des Temps for 1872. The result, as first published, was 160° 10′ 38″ west of Paris, or 157° 50′ 23.5″ W. of Greenwich, or 5.4 s. too far east.

But in No. 2586-7 of the Astronomische Nachrichten, for April, 1884, we find a reduction of Fleurials' observations for longitude, carried around the world in 1867-70. On pages 345-6 are given the single results obtained in Honolulu in October—December, 1868, 27 in number, and the longitude deduced from them is 10 h. 31 m. 25.59 s., or 1.3 s. too far east. These results were obtained by combining the observations at Honolulu with the actual observations of the moon's place made during the same period at Washington, Greenwich and Paris.

In September, 1874, Capt. G. L. Tupman, Royal Marine Artillery, in charge of the British Transit of Venus Expedition of that year, arrived in Honolulu, and established an observatory on Punchbowl St., near the shore, on practically the same meridian as C. S. Lyman's observatory, and 4.79″ west of Fleurials' pier. No pains were spared to ascertain the longitude by lunar observations, and the accuracy of the work has since been fully confirmed.

The observations for longitude were continued through the months of October, November and December, 1874. During this time over 700 meridional transits of the moon, thirteen occultations of stars, and about 540 zenith distances of the moon's upper and lower limbs, combined with those of well known stars near the moon, were observed. The first reduction of the observations apparently agreed with the result obtained by Prof. Lyman, viz.: 10 h. 31 m. 15 s., but after returning to Europe and correcting the tabular right ascension by the contemporary observations made at Washington, Greenwich, Paris, Konigsberg, Strasburg and the Cape of Good Hope, Capt. Tupman increased the result by about 12 seconds of time. His final result by meridional transits of the moon was 10 h. 31 m. 26.0 s.; by zenith distances, 10 h. 31 m. 27.3 s.; by occultations of stars, 10 h. 31 m. 26.9 s.

The result officially communicated to the Hawaiian Government Survey was 10 h. 31 m. 27.2 s., upon which all the maps since then have been based. It is interesting to note that this value agrees to the tenth of a second with the latest determination of the longitude.

Capt. Tupman, however, afterwards weighted the above results according to the number of observers employed on each, giving the occultation result the weight 5, the mean of the first two results the weight 4, and M. Fleurials' result the weight 1, on which conditions the resulting longitude is 10 h. 31 m. 26.3 s. If he had used the value deduced from Fleurials' work by the Astronomische Nachrichten, his final mean would have been 10 h. 31 m. 26.7 s.

In March, 1875, Capt. Tupman made an attempt to connect Honolulu with San Francisco by transportation of chronometers. Accordingly twenty chronometers were carried by H. B. M. S. "Reindeer," Com. C. V. Anson, from Honolulu to the U. S. Navy Yard, Mare Island, and compared with the local time at both stations. Unfortunately the "Reindeer" was blown out of her course by a northerly gale, which lengthened her voyage 7 or 8 days, and lowered the temperature in the chronometer boxes as much as 15° F. Hence the resulting determination of the longitude of Honolulu, viz.: 10 h. 31 m. 33.2 s. ± 3.0 s. W. had very little value.

Again, in August and September, 1884, an attempt was made by the Hawaiian Government Survey with the cooperation of Prof. Davidson and Mr. Morse in San Francisco, to determine the longitude of Honolulu by comparing the chronometers on board the O. S. S. Co. steamer "Mariposa," with the local time at each end. This was done for two round trips, giving a mean result of 10 h. 31 m. 25.8 s.

In view of all the above facts, the Hawaiian Government adopted 10 h. 31 m. 26.0 s. as the most probable value in rating chronometers and furnishing standard time, but not for mapping, until the recent telegraphic determination made by the U. S. Coast and Geodetic Survey.

CENTRAL POWER STATIONS WITH ELECTRIC DISTRIBUTION IN REGIONS OF SMALL WATER POWERS.*

By F. A. C. Perrine,† M. Am. Inst. Elec. E.

Throughout the New England region there are valuable power streams along which the rapid fall of the stream bed allows developments with heads of from 10 to 40 ft., at mill sites situated in distance from each other of from ½ to 5 miles. The mills using these have characteristically each a dam, a pond, and generally an auxiliary steam plant. This steam plant is useful not only when the water is insufficient, but also in operating the down-stream mills on summer mornings when the water in the ponds above has not yet reached its natural channel; though when once the flow has been established there is sufficient water for the operation of the mills, and during the majority of the working hours the steam plant is cut off.

Many of the mills so described have been located on account of the availability of the valuable water power and are to-day operating under great disadvantages from their inaccessibility, rendering necessary a heavy teaming bill for the haulage of raw material, finished product and coal. They are compelled to maintain extensive tenement districts in order to obtain operatives, though perhaps located within a short distance of a mill town or populous region. Furthermore, in order to permit an arrangement of the mill which will connect the machinery properly to the water-wheel, it frequently happens that they are located at sites entailing expensive original construction and unsatisfactory internal arrangements; besides, the location, along the streams often gives rise to great repair bills in times of flood, and finally, in such locations neither mills nor tenements are properly situated with reference to the best sanitary conditions.

As a consequence we find everywhere wasteful and expensive development of power, a lack of proper railroad facilities and a general disregard for manufacturing convenience in consequence of a choice of site rendered necessary by the domination of the needs of past methods of water-power development. The idea that I would bring forward is that of the centralized plant, developing power for the use of many cotton mills; I believe that the manufacture of the power should not be considered one of the provinces of a cotton mill superintendent. In many cases this means the purchase of power from an altogether independent concern from the mill itself, though in many

*Abstract of paper entitled "The Influence of Electricity on the Development of Water Powers," presented before the New England Cotton Manufacturers' Association at Lenox, Mass., Sept. 30, 1903.

†Pittsfield, Mass.

cases I hope in the future to see central power plants owned by the cotton mills, precisely as they own their insurance companies to-day, with a separate and efficient management and with a common interest and aim.

What I am intending to advocate is the complete development of the water powers in large units and not in small units, with auxiliary central steam plants, permitting at all times the distribution of constant power to the mills and the consequent location of the mills in reference to their product and operatives and not in reference to the power. In order to do this it is necessary to abandon the contemplation of small developments of individual falls and to substitute therefor the unification of many falls into one high head power wherever this can be accomplished by the means of flumes or dams. Whether this shall be done by the individual mills or a separate water-power company owned by the mills is a question for each individual case. Generally in sections thickly covered by mills and intersected by power streams there is no doubt but that the central plant can easily utilize and concentrate all powers within a radius of 35 miles, tying the auxiliary steam plants and water-power plants together by transmission lines so that the mills will be free, not only from the variation in the water supply but also from interruption of service due to break-downs of machinery.

It may be objected that the opportunities for accomplishing this have most of them altogether disappeared. This, indeed, is regretfully true, but it is not altogether true and we have to-day many streams throughout New England undeveloped on account of their fancied inaccessibility, which can readily become available if the question of the possibility of the site of the mill near the water power be considered as unimportant and if transmission distances of from 25 to 35 miles be contemplated.

The development of water powers at high heads has not only advantages on account of the fact that the inefficiency of many small wheels is eliminated but also from the standpoint of the storage reservoir, since with the high heads that are sometimes reasonably available the quantity of water necessary to develop a large power is so much reduced that reservoirs become important which under low heads are of inconsiderable capacity. Along the Boston & Albany Ry., between Becket and Chester, is to be seen an opportunity of carrying out such a plan as is here in mind. Whether the water in the Westfield River is sufficient for any development at that point is not here considered, but I assume that the water is in reasonable quantity as it is used to operate several mills a little below. You will observe as you are traveling along the railroad that a canal of about 5 miles in length along the hillside would give at its lower end a head of approximately 400 ft., and although there are no mill sites in the immediate neighborhood of such a possible power plant, there are good mill locations within ten miles down the valley.

The disadvantage of the location of mills along the rivers is most beautifully shown in our neighboring cities of North Adams and Adams, where we will find mill after mill with foundations sunk in the river beds at a very considerable expense and where once every five or ten years great repair bills on account of floods are encountered, though the configuration of the ground is such as would have permitted the consolidation of the water powers into one large, efficient central station plant.

The most notable example that has come to my attention of the wastefulness of low-head development is to be found at Holyoke where the canals consume space which should be available for good factory sites and where they are losing from 20 to 25% of the entire power developed by reason of the inefficiency of many low-head wheels in series. I claim that it would not be correct to object that in such a case as that of Holyoke the losses in the electrical machinery and transmission would more than counterbalance the increased efficiency of the water-wheels, since we all know that the introduction of the electrical drive will of itself overcome the loss from belting amounting to more than the inefficiency of the electrical machinery and whatever increased efficiency there could be gained by the high head would be clear gain and increased power.

I do not intend in any of these instances to question the judgment of the builders of mills or the developers of the water powers. The last generation certainly presented evidences of having at least as good a quality of brains as we have to-day; but I claim that simply because our forefathers worked out their problems as they did makes no reason for our slavishly following their footsteps when the work that they and we have done in other lines produces new conditions which make it unnecessary in the future to meet their disadvantages. The changes the past twenty years have made in the design of water wheels and improvement of electrical machinery and steam engines renders to-day available the use of high-water heads and long-distance transmission and auxiliary steam plants, not only without a necessary decrease of efficiency but actually with an increase of efficiency and an improvement in the quality of the product.

What is here advocated then is the development by means of long flumes in large central power stations of as many rapidly flowing streams as are available; the development of streams that by reason of their distance from satisfactory factory sites have heretofore been considered unavailable; the increase in size of the power plants and the uniting under one management as many power plants as possible; as well as the operation under the same management of steam auxiliaries necessary for the delivery of constant power, the abandonment by the cotton manufacturers, as far as is consistent with present conditions, of the generation of power as a part of their regular business and the placing of this work in the hands of experts who will install the machinery, make the power and deliver it to the mill for the operation of their dynamos, the location of the mills themselves at points adapted entirely to their manufacture, taking into account both the accessibility to railroads and the comfort and convenience of their employees.

The advantage of these principles has been widely appreciated in the regions of the Rocky Mountains and beyond. By their application the manufacturers of these regions have succeeded in overcoming their very great disadvantage of inaccessibility and expensive fuel, even where they have had to run flumes and ditches from 5 to 50 miles in length and have had to transmit power to such great distances that the limit I have set of 35 miles seems to the western engineers so short that they do not hesitate at rendering available powers that are at least 100 miles from a possible market.

THE NEW CANADIAN TRANSCONTINENTAL RAILWAY.

With reference to the article on the proposed Canadian National Transcontinental Railway, in our issue of Oct. 22, we have received from Sir Sandford Fleming, M. Am. Soc. C. E. (formerly Engineer-in-Chief of the Intercolonial Ry. and the Canadian Pacific Ry.), a copy of a statement of his views on the subject of the new line, submitted to the Council of the Board of Trade of Quebec on Oct. 6. From this we take the following extracts:

I again express the great satisfaction I have in knowing that the policy of the government is to establish a great national railway, and to open up for settlement and human industry the untilled and unoccupied habitable lands of the Dominion. I have the utmost faith in the wisdom of the policy. I have faith in an all-rail means of conveying the products of the farm to the seaboard. This policy is the true and only satisfactory solution of the great problem of transportation in the more northern latitudes of Canada. If asked what course should be followed, I would answer: Make haste, but make haste slowly and wisely. Do not lose a day in proceeding with the location of a railway that will carry grain from the distant prairie fields to Quebec cheaper than by any other route whatever. Having secured such a location, and not till then, employ every man, bend every back, strain every nerve, to complete the middle section of the line. This done, and not till then, proceed as it may seem best to complete from sea to sea the National Grand Trunk Transcontinental Railway.

Two things should be noticed: (1) That I deprecate commencing construction on any section before full and exact information be obtained respecting the physical features of the country; the object being to secure the very best location of the railway, which can possibly be had, having in view economy in transportation; (2) That in my judgment, it is in the public interest to defer proceeding with construction in the extreme eastern and the western portions of the project until the middle section, from Quebec to the prairie region, be completed. I am unable to discern that any public interest would gain, while I am satisfied that much loss would result, from any attempt to prosecute construction simultaneously over the whole line from ocean to ocean. There is no sufficient surplus labor in Canada to carry on such work throughout the whole extent of the line from the maritime provinces to the Pacific. To attempt to complete it within five years, or other short period, would necessitate bringing into the country an immense force of foreign labor. As a consequence, it is to be feared that the home labor market would be greatly disturbed, and moreover, the greatest disturbance would arise on the completion of the undertaking, when tens of thousands of workmen would be thrown idle. Such difficulties would be lessened or removed, by placing under construction in the first place only that section of the railway most needed, and by postponing, until its completion, construction on the other sections. As it seems to me, this course would be in the public interest, it certainly would be in the true interest of the Canadian workmen, and of the best class of industrial settlers whom we wish to become Canadians.

If we can determine the most important section, and the one most required, clearly on that section should be concentrated all the spare labor available in the Dominion. On its completion, new settlers and all desiring employment would find prolonged work on the remaining sections.

It will be further recognized to be of overwhelming consequence that the national railway be established, so as to bring the illimitable grain fields of the interior of the Dominion nearer the British market than by any other route, and so that the cost of transportation be reduced to a minimum. It was once accepted as a truth that transportation is cheaper by water than by rail. The axiomatic and generally accepted statement requires qualification under certain circumstances nowadays. Within the last quarter of century, transportation has been completely revolutionized by the extraordinary development of the railway system. Take for example, the Erie Canal:

FIG. 1. FOUNDRY AND PATTERN BUILDINGS, B. F. STURTEVANT CO., HYDE PARK, MASS.

The transportation of grain by that route reached its maximum in 1880. For 20 years it steadily decreased until 1900, when the amount carried was only one-fifth what it was in 1880. During the same period, the New York Central and Erie railways increased their tonnage in this class of freight no less than six times.

This result, indicating a remarkable change, is given on no less an authority than the President of the American Society of Civil Engineers, who made it public in his annual address delivered on June 9 of the present year. It certainly gives strength to the opinion, which I share, that there is a possibility of establishing a modern high-class railway direct from the wheat fields of the great Northwest to Canadian tidewater, which will all the year round

Fig. 2. Sturtevant Turntable and Industrial Railway.

outstrip any other means of communication. With these facts before them, together with other reasons, it seems to me that the public and their representatives will have no difficulty in reaching the conclusion that the section extending from Quebec to the Saskatchewan is by far the most important portion of the projected transcontinental railway, that it should be the first undertaken, and as speedily as possible constructed.

On other occasions I have pointed out that there is a choice of gateways for railways to enter the prairie region

from the east. There is one to the south, and another to the north of Lake Winnipeg. The grain grown in the southern half of the prairie region, tributary to the City of Winnipeg, will find its readiest outlet by the southern gateway. It will continue, as now, to seek its way to market by the Lake Superior route, and by such channels to Montreal as are already open, or by other channels, such as the Trent Valley navigation, hereafter to be opened. It will be found, however, that the products of the much larger northern portion of the fertile plains may reach market more easily by the northern gateway; that the grain and cattle of the rich Saskatchewan and the vast regions beyond, the bread and beef for Great Britain, may reach their destination most cheaply by a railway following the shortest route to Quebec. The northern route would in no way be affected by the closing of navigation on the Lakes; it would be entirely free from the abnormal haste incident thereto, during the short period after harvest when it is possible to despatch the year's crop to market. Wheat would be transported by the northern route with the utmost regularity to Quebec, there to be stored in readiness for the spring fleet, or if advantageous to do so, at any time during the winter, it may be forwarded to the open ports of the maritime provinces for ocean shipment.

Having regard to every consideration, it seems to me

Fig. 4. Foundry Dump Car.

obvious that whatever view may now be held, the day is not distant when it will universally be recognized that the true location for this section of the new national railway lying east of the prairie region, is by the northern route. I know of no undertaking which promises to be of more general advantage than this particular section. On the other hand, as a moderate means of communication from the Saskatchewan country, running direct to Quebec, it would bring the heart of the granary of the empire into connection with the tidal waters of the Atlantic, and in touch with the British fleet. On the other hand it is difficult to conceive any single public work which would so much tend to consolidate Canada, or in a higher degree benefit and advance the Dominion as a whole.

THE NEW STURTEVANT FOUNDRY AND SOME DETAILS OF ITS INTER-TRANSPORTATION SYSTEM.

Thoroughly modern foundry and pattern department buildings have recently been erected by the B. F. Sturtevant Co., at Hyde Park, nine miles from Boston, where a tract of 15 acres was secured for the new site of the plant. The foundry and pattern buildings, Fig. 1, are now in service, and some details of the transportation system, which has been admirably worked out, will be given.

The foundry consists essentially of two long craneways, each 35 ft. wide, a center bent of the same width, and side floors 30 ft. wide. The brass foundry, core room and wash room are located at one end; the charging floor at one side, nearly midway of the length; and the cleaning room at the other end. The craneways are designed for 20-ton electric traveling cranes. Those already installed are of the Whiting Foundry Equipment Co.'s make and are equipped with Sturtevant motors.

Brick division walls 3½ ft. high running lengthwise of the foundry separate the floors on the lines of the columns. Lighting is secured through monitors in both of the craneways and through ample side windows. Each line of monitor transoms is operated in unison by a novel device installed by the G. Drouve Co. The western side

Fig. 3. Sturtevant Turntable, with Cover Raised.

of the foundry is given up to bench and small floor molding, the bench molders' floors being separated at the bench ends by wooden partitions. The floors throughout this side of the building as well as those in the storage bins and center runways are of concrete. Alongside the industrial railway, which serves iron from ladle trucks to the bench floors, is a sunken trench laid with common brick as a suitable place for drippings and for the piling of hot castings.

In the center line of each of the craneways and in the bent between them runs an industrial railway with turntables connecting with the cross aisles which provides for the distribution of metal, etc., to all parts of the building. The floor between the craneways is supplied with a series of 1½-ton small traveling cranes of about 10 ft. span, equipped with Sturtevant electric hoists, built especially for this work.

The industrial railway is laid with 12-lb. rails to a 24-in. gage, and is provided with turntables, as shown in Figs. 2 and 3, there being no switches anywhere in the plant. As a consequence, all cars have rigid bases.

A dump car and a ladle truck of special design are shown in Figs. 4 and 5, while one of the cupola-charging cars is shown on the charging floor, Fig. 6. The method of handling these charging cars has some unique features. The charging car after being loaded on the first floor is run into an elevator and raised to the charging floor, where it leaves the elevator, as shown in Fig. 6. After unloading, the car passes over the knuckle onto the "car shute," Fig. 8, and runs by gravity toward the elevator at the other end of the track. To bring the car to rest without impact, the track is given an upward pitch, as shown in Fig. 8; but in order to absorb the residual velocity, an ingenious car-stopping device is inserted between the points A and B. This device is shown in detail in Fig. 9.

As shown in Fig. 9, the axle upon which the car wheels, W, turn, strikes a sliding hook, H. This hook is fastened to a cable that passes around the fixed sheave, R, and then around the movable sheave, T, and back to an anchorage. The sheave,

Fig. 5. One-Ton Transfer Ladle Truck.

T, is mounted on a cross-head provided with a piston rod and piston that slides in the cylinder, C. The opposite ends of the cylinder, C, are connected by pipes to a water main having a pressure of 100 lbs. per sq. in. It is evident that when the car axle strikes the hook, H, the hydraulic piston

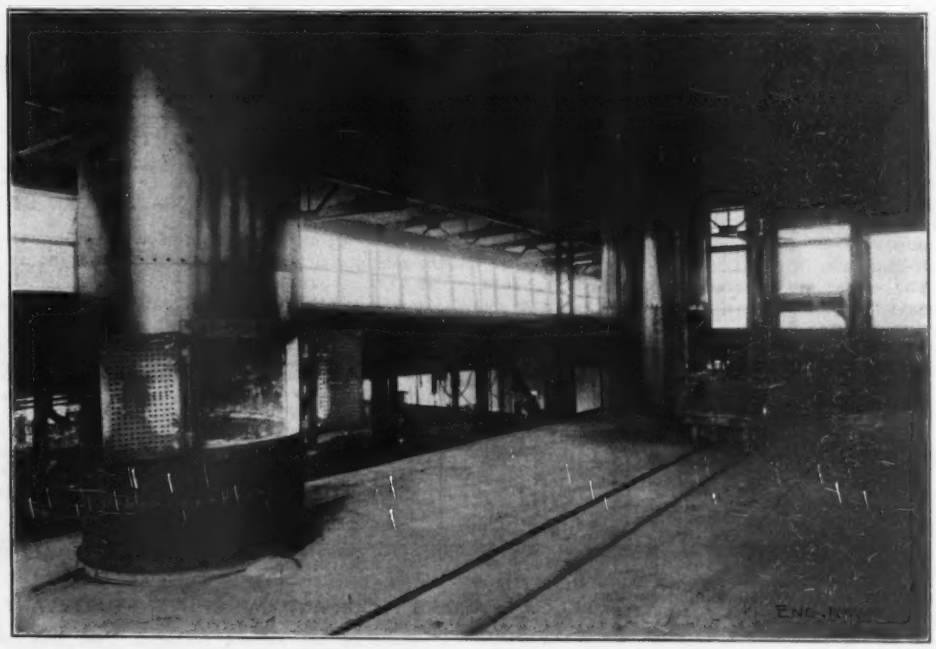


FIG. 6. CHARGING FLOOR, STURTEVANT FOUNDRY.

is made to operate against the resistance developed by the throttling gate, G. To take up the shock due to the impact of the descending car, there is a spring, S. This spring also serves to

hold the hook in contact with the car axle until the car comes to rest, when the weight of the hook causes it to fall and relase the car. The car then runs the remaining short distance down the 5% grade, and enters the elevator, where it trips

FIG. 7. WASH AND LOCKER ROOM.

an automatic release that causes the elevator to descend.

The car-stopping device automatically returns the hook, H, to its normal position, for the water pressure on the upper face of the piston exceeds that on the lower face by an amount proportionate to the area of the piston rod.

Returning again to the turntable construction, it will be seen, Figs. 2 and 3, that the tables are made very heavy to avoid distortion or breakage, and consist of a bottom frame of four roller wheels, which are carried upon composition trunnions, and a cover, which is recessed for crossing tracks at right angles, and provided on the under side with a chilled tread with which the wheels come in contact. A small idler wheel is provided which automatically stops the turntable on each quarter, but readily releases it. The cover is accurately centered by a chilled conical bearing.

The cars, it should be added, are all provided with a special type of ball-bearing in which very little machine work enters, chilled wearing surfaces being used instead. The ordinary flat cars as well as the charging cars are built up of structural steel. The geared ladle cars have malleable-iron frames and enclosed spur gears. The conical dump cars are so balanced as to be practically self-dumping.

The entire transportation equipment of cars, trucks, turntables, tracks, etc., was designed and built by the B. F. Sturtevant Co., while the architects and engineers were Lockwood, Greene & Co., of Boston.

One of the noticeable features in the equipment of this plant is to be found in the sanitary arrangements. The foundry is provided with a large wash and locker room, Fig. 7, where 225 expanded metal lockers are already in position. A series of slate partitioned shower baths has been much used by the employees during the summer. The floor of this room is of tar concrete.

Naturally the entire plant is heated and ventilated with Sturtevant apparatus, and the system in each building is under thermostatic control. Distribution of air is made through overhead galvanized iron pipes, discharging downward to the floor. A complete underground tunnel system is provided for the distribution of steam, compressed air, oil, electricity, etc., from the power house to the various buildings.

It will be apparent, even from this brief review of some of the salient features, that this new manufacturing plant is well worthy of study by those having similar plants to design.

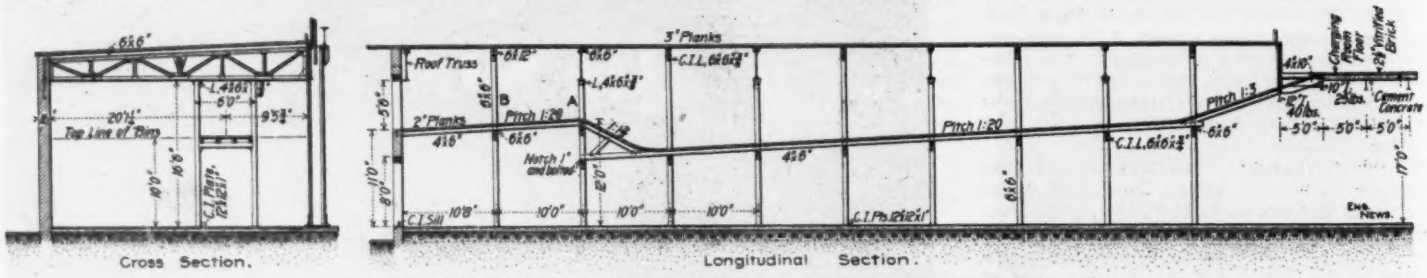


FIG. 8. CHARGING FLOOR AND CAR CHUTE, STURTEVANT FOUNDRY.

AN AUTOMATIC VALVE FOR CUTTING OUT THE METER ON A FACTORY FIRE SERVICE.

One of the most annoying questions before water-works officials at the present time is how to remedy the unregistered use of water by persons having private fire service mains to their property. The amount of water taken from such services in large manufacturing cities is known to be large, and for it, under the present conditions, no return is received by the city. Such conditions are obviously wrong, and water-works officials are naturally anxious to secure some remedy for them. The most natural remedy of metering the fire services has proved impracticable for the reason that any form of meter which will register small flows is objected to by the insurance interests because it reduces the fire pressure, while any form of meter which does not reduce the pressure is objected to by the water-works officials because it does not register the small drafts which it is their object to check. The metering of the services in the regular way being out of question, numerous attempts have been made to design an alternative device which will satisfy both the insurance interests and the water-works officials, and the latest apparatus of this kind was tested at Burlington, Vt., on Oct. 16, under the drection of the Fire Insurance Committee of the American Water-Works Association. This test was simply an exhibition test conducted for the benefit of a number of water-works officials and delegates from the New England insurance companies, and forms only one of an elaborate series of tests which will be conducted and reported upon by the committee named above. The results obtained in the exhibition test were so interesting, however, that we believe that it will be instructive to many of our readers to present the following account, prepared from the notes of a member of the editorial staff of Engineering News, who was present.

The device tested at Burlington is the invention of Mr. J. A. Tilden, of the Hersey Mfg. Co., of Boston, Mass., and its construction and operation can be explained by the accompanying diagram. perforated and its stem rising up into a cylinder

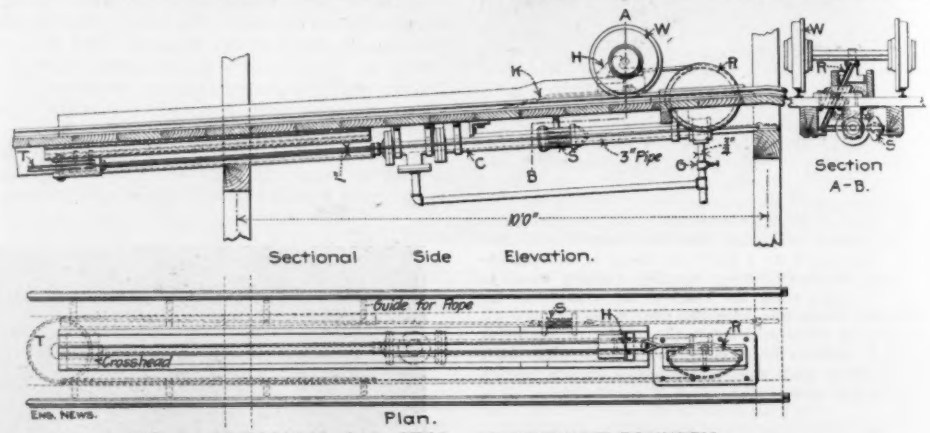
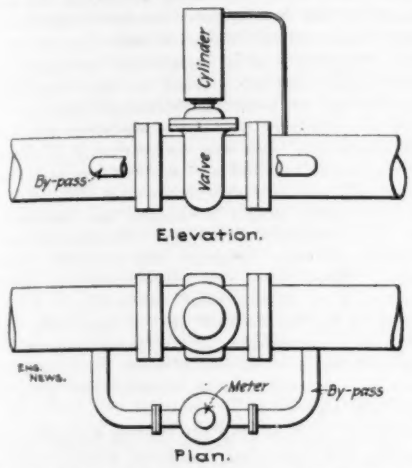


FIG. 9. HYDRAULIC CAR STOP, STURTEVANT FOUNDRY.

This diagram shows a 3-in. by-pass in a 6-in. service main. A valve is located in the main between the by-pass connections. This valve is an ordinary double-gate valve with one of the disks and having a cup-leather piston between brass disks at its top. An annular space between the casing and the valve stem admits the water from the inlet side freely up under the piston. The top of the cylinder being connected by a small pipe to the main on the outlet side, water from this side is admitted freely to the top of the piston. So long as the water pressure on the inlet and outlet

sides of the gate is identical, it is evident that the valve will remain inoperative. As soon, however, as the pressure on the outlet side is reduced, as by drawing a fire stream, the excess pressure of the inlet side, acting on the underside of the piston, raises the gate and throws the main open. By closing the draft from the outlet side equilibrium of pressure is restored and the gate closes by its own weight.

It is plain from what has been said that by weighting the piston on top any draft from the



Automatic Valve for Cutting Out the Meter in Factory Fire Service.

outlet side up to the specified reduction in pressure counterbalanced by the weight can be provided for without operating the valve. Thus supposing the valve is weighted to operate only after a reduction of pressure of 5 lbs. per sq. in., it is then obvious that any amount of water may be drawn from the outlet side up to the amount which will reduce the pressure more than 5 lbs. To provide for this draft and to measure it is the object of the by-pass, in which is set a Hersey disk meter. The factory owner can, therefore, draw from his service any amount of water up to that amount which will reduce the pressure 5 lbs., and the amount drawn is registered by the meter. Should he put a greater draft on the service the valve will open and this fact be registered by a tell-tale device for the information of the water-works officials. Again, should fire occur the great draft on the service will cause the valve to open wide and leave the service main free to supply water to its full capacity for fighting the fire. As soon as this emergency draft is shut off the valve closes and the by-pass and meter become operative again for registering and supplying the normal demand.

The object of the exhibition tests made at Burlington was to demonstrate that the device would operate as it was designed to operate. The valve was weighted to operate at 6 lbs. per sq. in. reduction of pressure. Arrangements were provided for taking streams from the outlet side varying from 1-16-in. to 4 ins., for weighing the water up to the 2-in. streams, and for gaging the reduction of pressure. In the test the valve opened when the gages registered a reduction in pressure of 6 lbs., and closed again when the reduction registered 5½ lbs. The meter registered all streams less than that necessary to give the 6 lbs. reduction in pressure required to open the valve. On the full series of tests, which will be conducted by the committee, very elaborate records will be taken of meter efficiency, nozzle pressure, etc., and these will be fully reported by the committee at some future date. In conclusion, particular credit should be given to Mr. Tilden, of the Hersey Mfg. Co., who provided the apparatus for the test, and to Mr. F. H. Crandall, Superintendent of Water-Works of Burlington, Vt., for installing the testing plant and conducting the tests on behalf of the committee.

A NEW TYPE OF STEEL HOPPER CAR.

The Wellman-Seaver-Morgan Co., of Cleveland, O., has recently built a steel car of 100,000 lbs. capacity, which is a decided departure from any of the designs in use.

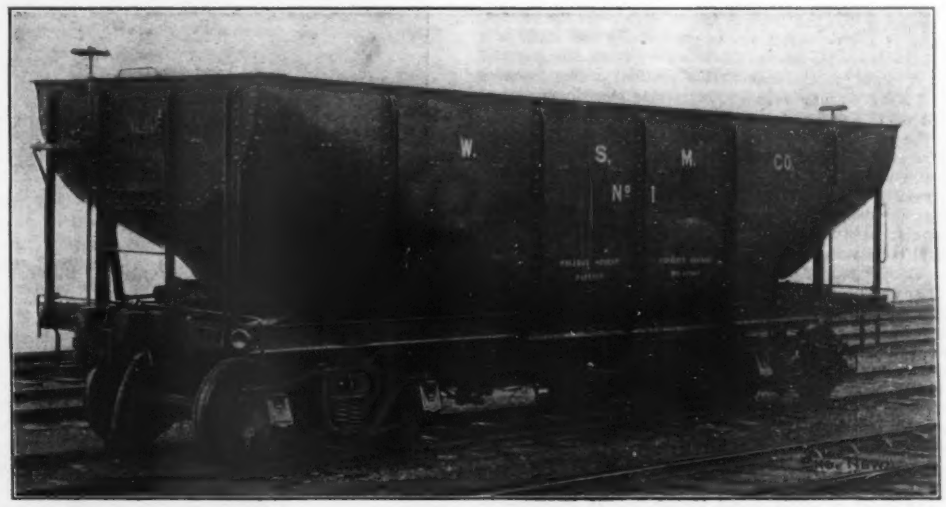
This car is built under patents issued to Messrs. S. T. Wellman and Clement F. Street, and its general appearance is showin in the accompanying illustration, which is reproduced from a photograph. The principal object in view by the designers was the reduction in the number of points susceptible to corrosion. Other objects in view were the production of a car which would be self-clearing and one which could be repaired at a low cost.

The center sills consist of two 15-in. channels with flanges turned in. A gusset plate is riveted to the outside of each channel and extends from one center plate to the other. An angle-iron is riveted to the lower edge of this gusset plate, giving a girder 27 ins. deep at the center, and extending from truck to truck. This girder is designed to have ample strength for carrying the entire load of 100,000 lbs. The side plates are curved, and the customary form of side sill is eliminated. This curved form of plate should enable the car to clear readily and also have the minimum lineal feet of joint exposed to load. Measurement shows this latter to be 45% less than in the common form of car. The makers claim that as corrosion begins at these points, the life of this car will be very much longer than that of any other in use.

The elimination of the customary form of side sill makes a material reduction in dead weight, which weight has been put in the plates of the car, where it is believed to be more useful. These plates are 5-16-in. thick, or 1-16-in. heavier than those usually used. An important advantage claimed is the large area of door openings, which is 56 sq. ft. In many steel cars this is only from 20 to 25 sq. ft. This large door opening, together with the curved form of plate employed, should enable the car to clear readily.

The ends of the center sills are tied together by a heavy steel casting, which forms the central part of the end sills. The ends of the end sills are formed of short pieces of 8-in. channels, securely riveted to the steel castings referred to, and extending to the side of the car. The push-pole socket is riveted to these channels and also to a short 8-in. channel, which extends from the corner of the car to a heavy steel casting riveted to the side of the car close to the door opening. This construction is further stiffened by two angle irons extending from the corner of the car back to the body bolsters near its junction with the center sills. Damage to steel cars is often caused by corner blows, and this construction is designed to enable the car to be easily repaired. The idea is that under a corner blow the only parts receiving damage will be the channels and angles referred to. As these are commercial shapes, they can be readily renewed, or if not too badly damaged can be straightened and replaced.

The car is at the present time in service between Cleveland and Pittsburg, carrying ore and coal. It is giving excellent satisfaction, and the company expects in the near future to begin manufacturing them in large numbers.



A NEW TYPE OF STEEL HOPPER CAR.
S. T. Wellman, Past-President Am. Soc. M. E., and Clement D. Street, M. Am. Soc. M. E., Inventors.

CENTRAL HEATING PLANTS AT INDIANAPOLIS, IND.*

By W. K. Eldridge.†

Central station heating plants are rapidly growing in popularity. Particularly is this true in central and eastern Indiana, where the conveniences of heating by natural gas have instilled in the people a strong aversion to the return to coal handling and firing for their stores, office and dwellings, which is fast being forced upon them by the failure of the gas fields. In conjunction with plants for the production of light and power (the exhaust steam from which was in former times largely allowed to go to waste), a revenue is derived from this erstwhile waste product by rates easily within the reach of consumers in even moderate circumstances. It is not strange then that central station heating should be a most attractive consideration to both producers and consumers, and in the case of municipal electric light works it might often transform a taxing proposition into a self-supporting one. Such plants are beginning to have a great vogue in the smaller cities of the state, the writer and his partner (but one firm among many) having been connected with the installation of systems in Newcastle, Peru, Connersville, Terre Haute, Fort Wayne, Lafayette and Bloomington, Ind.; Mt. Vernon, Ill., and Springfield, O., within the space of a single year. All these plants are operated in conjunction with electric lighting, and in two cases with the production of artificial gas, in addition.

In 1890, the Home Heating & Lighting Co., of Indianapolis, obtained a franchise from the city for an area of about 2¾ sq. miles in the north part of the city surrounding the location of the works at Alabama and 16th Sts. This plant is designed to furnish hot water and electric light, and now has about nine miles of double piping and 13 miles of pole line. The total radiation in service is now about 325,000 sq. ft., taxing the plant to its fullest capacity in the severest weather, so that large additions are being considered. The boiler capacity is 1,800 rated HP., and the lighting capacity 250 KW., furnishing alternating current at 2,250 volts. The service is almost wholly residential. The water is heated by the exhaust steam, reinforced with live steam automatically, whenever necessary, and is circulated through the mains and radiators by means of powerful pumps. This plant is the largest for hot water heating yet installed in the United States.

The Marion County company is now breaking ground for the foundations of its power house, to be finished next year with complete electric lighting and hot water equipment.‡

As exemplifying how factories and other enterprises producing power may thus utilize their waste steam for revenue, the writer will instance the Century Building, in Indianapolis, owned by John W. and Edward Schmidt, with the erection of which the writer was connected. This building of seven stories and basement covers an area of 135 × 195 ft., affording a net rentable area on each floor

*Abstract of a paper read at the annual meeting of the American Society of Municipal Improvements, held at Indianapolis, Ind., Oct. 20, 23.

†13 Ætna Building, Indianapolis, Ind.

‡The plant of the Marion County Hot Water Heating Co., referred to by Mr. Eldridge, is to cost, it is said, about $250,000. There will be two boiler rooms 82½ × 120 ft., and 41 ft. high, with a 13-ft. basement. The engine-room will be 200 × 100 ft., 42 ft. high, with a 9-ft basement, and will have a 50-ton electric crane. There will be three brick chimneys 250 ft. high, of which one will have an inside diameter of 19 ft., while the others will have a diameter of 10½ ft. The boilers will have a capacity of 10,000 HP., only half of which will be at first installed. They will be equipped with automatic stokers, supplied from an overhead bunker of 850 tons capacity. The engine-room will contain generators directly driven by Curtis steam turbines of 2,500 HP. and 7,500 HP., with an overload capacity of 50%. The plant will distribute hot-water or steam heat within a ½-mile radius, and will also supply electricity for heat and power purposes. The electric service is to be ready by March, while the heating service will not be ready before November, 1904.—Ed.

of about 20,000 sq. ft. On each floor are from two to a dozen tenants engaged in manufacturing, and furnished with heat, light, water and power from a steam plant in the basement. The latter consists of two Stirling boilers of 200 HP. each, to which is now being added one more of 250 HP.; two engine-dynamos of 50 KW. and 30 KW., respectively, to which is now being added a new Corliss engine of almost 200 KW. capacity. The heating system of the building is by exhaust steam with vacuum return. As it was found that much more steam was required for power than was necessary to perform the heating service, steam pipes were run in several directions to many of the neighboring buildings, including a four-story office building covering 14,000 sq. ft. of ground. This did away with at least a dozen smoky chimneys in the heart of the business district, about which there had been much complaint. This last feature is not one of the least advantages connected with a central heating system.

A citizen who has a large rental property in the north part of the city, put in a central heating station for his cluster of houses, and has applied for a franchise enabling him also to supply the neighboring houses in the same square.

The most important enterprise of this nature in the city is that of the Merchants' Heat & Light Co., which has seen one winter of service. Its franchise covers the so-called original mile square of the city, which gives it access to the main wholesale and retail centers, public buildings and other business territory. The writer and his partner were also connected with the installation of this enterprise. The power house is located in South New Jersey St., half a square south from Washington St.; from this is distributed electric light and power, and direct steam heat on a single pipe system. The building comprises an engine room, 30 × 90 ft., with basement for heaters, condensers, piping, etc., and a boiler room 45 × 90 ft. It is so located that the capacity of each room may be doubled by future extensions. In the boiler room is installed a battery of seven Wickes upright water-tube boilers with Roney stokers, giving an aggregate of 1,750 HP., and working up to 2,100 HP. The future addition to the boiler room will afford space for seven more boilers of the same type, facing the present battery, and it is the intention at that time to install overhead storage bins between the two batteries for the coal, with spouts leading to the hoppers of the stokers. A railway siding runs along the south side of the building. A tunnel under the ash pits (not yet in use) is intended to provide space for ash-handling machinery in the future.

The products of combustion are discharged on the down-draft principle into a smoke duct 6 × 9 ft., running along the floor behind the boilers. This turns into a smoke tunnel along the north wall of the room, and running underground through the back yard to the chimney, which is circular, 9 ft. diameter and 165 ft. high from the ground, built of hollow radial blocks. Adjoining the stack is a cooling tower for the condenser water, 13 ft. diameter and 32 ft. high. In the engine room are four engine-dynamos of 1,200 KW. total capacity, furnishing electric current at 230 volts, three-wire system.

The street system consists of the steam mains, electric wire conduits, and a compressed air pipe. The principal steam main is 20 ins. diameter, and runs west in Washington St. for about 2,800 ft. to the first reduction. Altogether about 16,000 ft. of steam piping, and 150,000 ft. of conduit have been laid, and the work still goes on. The total radiation expected to be supplied this winter amounts to 175,000 sq. ft.

Expansion joints, accessible from manholes, are placed in the steam mains, about 150 ft. apart, with anchorages midway; all steam mains are enclosed in several thicknesses of insulation and boxed in. A 3-in. compressed air pipe is run in the same trench, the compressed air being for the purpose of operating the shut-off valves in the various buildings supplied. In each building are placed one or more thermostats, by the action of which the compressed air is admitted to or released from the shut-off valves. Not only is the temperature of the building thus regulated, but a material saving of steam is effected.

The water of condensation in the various buildings is utilized in boxed coils in the basement for indirect radiation, the warmed air passing through registers in the floor above. By this means several desirable results are obtained. The room heated derives the benefit of a certain amount of fresh warmed air, in addition to the direct steam heat, and an equivalent amount of steam is saved. The net result to the company is a higher economy than if the water were returned to the station, which would require a complicated system of piping, vacuum pumps, etc., with added risk of getting out of order. Wherever it is desired, the hot water is further used as water, as in hotels, etc., with addition to revenue; otherwise it runs off into the sewers. Low points in the street mains are trapped into the sewers.

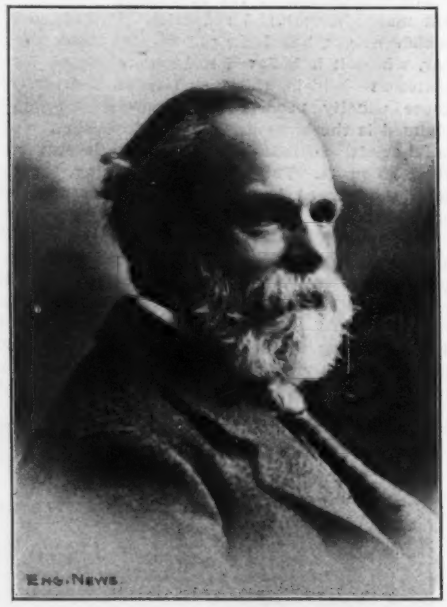
In the same trench, to one side of and a little above the steam main boxing, are laid the electric wire conduits, leaving the power house 20 in number, of which 15 are at present occupied with cables of a total capacity of 5,300 amperes at 115 volts pressure. The construction and means of access are of the usual style for such work. Nearly all the trenching has been cut in sheet asphalt.

The incorporators of this project include many of the most prosperous merchants of the city, the first idea having been almost of a co-operative nature for their own relief and service, but soon extended to its present magnitude. The work has been done by Mr. William H. Schott to the entire satisfaction of the company.

ROBERT HENRY THURSTON.

The death of Dr. R. H. Thurston, Director of Sibley College of Mechanical Engineering of Cornell University, which was briefly noted in our last issue, takes away one of the most prominent and best known members of the American engineering profession, who will be mourned as a personal friend by great numbers of men who were under his tuition as well as by hundreds of engineers who had had the privilege of his acquaintance. As announced in our last issue, Dr. Thurston died very suddenly of heart disease at his home in Ithaca, N. Y., on his sixty-fourth birthday.

Dr. Thurston was born in Providence, R. I., Oct. 25, 1839. He was the son of Robert L. Thurston, who was the proprietor of an establishment then especially devoted to the manufacture of steam engines. In these shops the son spent much of his youth, and developed an inherited taste for mechanical engineering. In 1859 Robert H. Thurston was graduated from Brown University with the degree of Bachelor of Philosophy, and he at



Robt H. Thurston

once entered his father's works, where he acted for a time as designing engineer.

At the outbreak of the Civil War, in 1861, he entered the U. S. Navy as an Assistant Engineer, and served with the fleets of Admiral Dupont and Dahlgren until the close of hostilities, having been commissioned, in 1864, First Assistant Engineer, in the Steam Engineering Corps of the U. S. Navy. From January, 1866, until June, 1871, he was Acting Assistant Professor of Natural Philosophy at the U. S. Naval Academy.

When the Stevens Institute of Technology was founded, he was called to that institution as professor of mechanical engineering, and, with the exception of the late Dr. Henry Morton, was easily the most prominent figure in its faculty. The work which he carried on there in experimental research and other fields established his reputation as an engineer and a teacher.

In 1885, President Andrew D. White, of Cornell University, called Dr. Thurston to that institution to assume the directorship of the new Sibley College of Mechanical Engineering, and to the development of this institution he devoted the remainder of his life.

Upon assuming the office of Director of this college he was given by the Board of Trustees unusually broad authority, and though the foundation had been well laid in the admirable work performed by Prof. J. L. Morris, Dr. Thurston must be credited with the plan and development of the professional and graduate courses, in the main lines of mechanical engineering and its important branches, which have made Sibley College so prominent a department of the University. In 1886 there were only eight graduates from the college; in 1903 there were 120; and the total registration in Sibley College has increased from about 60, in 1886, to nearly 1,000 at the present date. This growth has been necessarily accompanied with a corresponding growth in the personnel of the faculty and teachers, and in the material equipment of the college.

Dr. Thurston's wide reputation, however, was undoubtedly due even more to his voluminous contribution to technical literature than to his work as a teacher. The list of his books alone is a formidable one, and his contributions of formal papers to professional and scientific societies and periodicals are said to number over 300. Among his best books should be named the "Manual of the Steam Engine" (1890-91); "Manual of Steam Boilers" (1890); "Engine and Boiler Trials" (1890); "History of the Steam Engine" (1878); "Materials of Engineering" (1882-86).

It need hardly be said that a man who could write so voluminously, at the same time that he was carrying a multitude of other responsibilities, must be an indefatigable worker; and such Dr. Thurston was.

It is not strange that his tireless industry wore out the not over-vigorous body before reaching the alloted three-score years and ten. It may be recalled that nearly twenty years ago, Dr. Thurston's health gave way and he had to give up work and enter a sanitarium; but a short period of rest enabled him to again take up his work.

Besides his other activities, Dr. Thurston acquired some reputation as an inventor, chiefly in connection with his work in original investigations. His oil-testing machines and his torsion-testing machines are most familiar to engineers; but he also made inventions in magnesium-burning lamps, signal apparatus for the army and navy, various machines for testing the properties of iron and other metals and for ascertaining the properties of lubricants; and in addition to this work he made improvements in steam engines and in existing scientific apparatus. He performed much original work in scientific investigation in connection with engineering problems, and he is credited with having organized in 1872-73 the first laboratory in the United States for research in the applied sciences of engineering. Among some of the more important results of this work of Dr. Thurston may be mentioned the determination of the useful qualities of alloys of copper and tin and copper and zinc; his studies and conclusions upon boiler explosions; his investigation of the laws of friction and lubrication, and of the laws of variation of engine-waste in heat and power; and his studies in the field of the commercial economy of steam engines.

As an engineering expert, the United States Government frequently demanded the services of Dr. Thurston. He was a member of the U. S. Commissions sent to the Vienna International Exposition of 1873 and to the Paris Exposition of 1889; the U. S. Commission to investigate the cause of boiler explosions (1875); the U. S. Commission to test iron, steel and other metals (1875-1888); the U. S. Commission on Safe and Bank-Vault Construction (1891), and the U. S. Board to report on the construction of the iron-clad "Puritan," Dr. Thurston became a Member of the American Society of Civil Engineers on Dec. 6, 1871; he was the first President of the American Society of Mechanical Engineers, holding that office two years, and he was three times Vice-President of the American Association for the Advancement of Science. He was also a member of several European scientific associations, and he had received the degrees of C. E., Ph.B., A. M., LL.D. and Dr. Eng.

Dr. Thurston was first married in 1865, to Susan Taylor Gladding, of Providence, R. I., who died in 1878; in 1880 he married Leonora Boughton, of New York, who survives him with three daughters; one of the latter is the wife of Prof. Victor Coffin, of the University of Wisconsin.

A NEW TYPE OF REINFORCED HOLLOW TILE WALL CONSTRUCTION.

Walls for mill buildings made of hollow tiles reinforced or bonded in a novel way with strap iron are claimed to be cheaper than brick walls, and preferable also because of their light weight. During the past year a number of buildings have been erected in which this form of wall, shown in Fig. 1, has been used. One of the recently finished buildings of this type is that of the Barber Asphalt Paving Co., at Maurer, N. J., Fig. 2. The walls are made of hard-burned terra cotta blocks (4 ins thick, 8 ins. high and 12 ins. long), laid between upright I-beams. The I-beams may be 6 to 12 ins. deep, according to the thickness of wall desired, and are ordinarily spaced 15 or 16 ft. apart. Riveted to these I-beams and laid in recesses between the tile blocks, are strips of band iron (1-16 × 1 in.) imbedded in Portland cement mortar. These band-iron strips serve to bond the wall and give it lateral rigidity; and being imbedded in mortar they are not subject to corrosion. The air in the hollow spaces of the tile blocks, being a non-conductor, makes a comparatively thin wall of hollow tile as effective as a much thicker wall of solid brick.

The great saving in weight per square yard of wall results not only in a saving of freight and cartage, but it enables the engineer to design a lighter foundation.

The "Phoenix" wall, as it is called by the manufacturers, was selected last year by the engineers of the American Smelting & Refining Co., of Perth Amboy, for a 200 × 350-ft. tank house, having walls 4 ins. thick and 24½ ft. high, with 12-in. I-beams spaced 16 ft. apart.

The crushing strength of these hollow blocks, as determined with a Reihle testing machine, is 59.6 tons per sq. ft., the blocks being set on edge as in the wall. The surface of the blocks may be ribbed, as in Fig. 1, to give a bond with any finishing that may be used, or the surface may be perfectly plain.

The following is the estimated cost of a 4-in. "Phoenix" wall (15 ft. high):

Materials.

One 6-in. upright I-beam for every 15 ft. of wall (one beam to every 25 sq. yds. of wall), weighing 14¾ lbs. per ft. = 227¼ lbs. for 25 sq. yds., or 8.84 lbs. per sq.yd. at $2.65 per 100	$0.24
Band iron (1-16-in. × 1-in. wide) laid on every course of blocks; 350 ft. of iron to every 25 sq. yds., or 14 ft. per sq. yd., weighing about 1¼ lbs. at $3.20 per 100 lbs.	.04
Portland cement, for every 150 ft., 1 bbl. at	$2.50
Sand, ½ cu. yd.	.63
Cost per sq. yd.	.19
"Phoenix" blocks (4×8×12 ins.), 9 sq.ft. at 12 cts.	1.08
	$1.55

Labor.

A mason will easily lay in 8 hrs. 150 sq. ft. of these blocks at 65 cts.	$5.20
Helper, 8 hrs. at 37½ cts. per hr.	3.20
Total for 150 sq. ft.	$8.20
Cost per sq. yd. for labor	.50
Cost per sq. yd. of "Phoenix" wall	$2.05

It will be seen that this cost is considerably less than for the ordinary 12-in. brick wall.

A comparison between the weights of brick and of hollow-tile walls is of interest. Assuming hol-

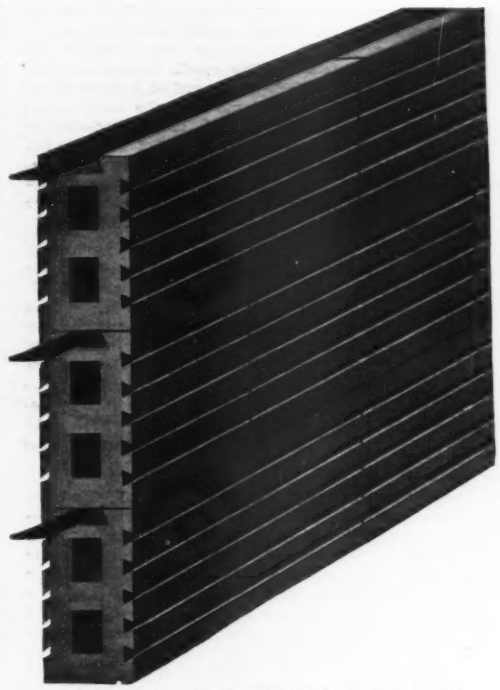


Fig. 1. The "Phoenix" Hollow Tile Wall.

low-tile blocks to weigh 16 lbs. each, we have the following estimate for a wall 15 ft. high and 200 ft. long:

	Lbs.
4,500 "Phoenix" blocks (4 × 8 × 12 ins.) at 16 lbs.	72,000
I-beams	2,780
Band iron	700
Total	75,480

The same wall if made 12 ins. thick of brick would contain 3,000 cu. ft., which even at the exceedingly low estimate of 100 lbs. per cu. ft. would give 300,000 lbs. for the weight of the wall, including the mortar.

The buildings shown in Fig. 2 are roofed with red clay roofing tile of the interlocking type, manufactured, as are the "Phoenix" blocks, by Henry Maurer & Son, 420 East 23d St., New York. This same firm has recently put on the market a "glass tile" made of exactly the same pattern as their clay tile. These "glass tiles" are transparent, and by substituting a number of them for the opaque clay tiles, skylights may be entirely dispensed with. Moreover, the cost of maintenance of skylights is thus done away with, and at any time the area of transparent tiling may be increased or diminished at slight expense. The glass tiles are of tough glass, and when interspersed among the clay tiles of the roof give a pleasing appearance.

For railway sheds, warehouses, stations, etc., the hollow tile walls with tile roofs would seem to merit the careful consideration of engineers.

We are indebted to Henry Maurer & Son, of 420 East 23d St., New York, for data and for photographs from which the cuts have been made.

FIG. 2. BUILDINGS OF THE BARBER ASPHALT PAVING CO., AT MAURER, N. J., WITH HOLLOW TILE WALLS.

STEEL TIES ON THE BESSEMER & LAKE ERIE R. R.

One of the few cases of the use of metal ties in this country is on the Bessemer & Lake Erie R. R., and it is interesting to note that this particular experiment, with about 1,000 ties, was instituted by Mr. H. T. Porter, Chief Engineer.

The tie, shown in Fig. 1, consists of a length of rolled trough plate (Carnegie section M — 14, ¾ ×

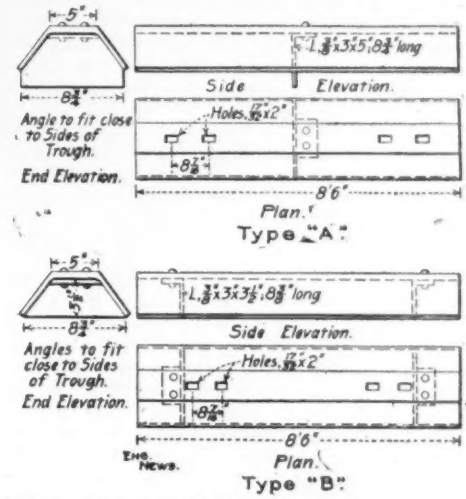


Fig. 1. Experimental Steel Ties on the Bessemer & Lake Erie Ry. H. T. Porter, Chief Engineer.

3¾ × 9½ ins.), forming an inverted trough. The tie is 8 ft. 6 ins. long, 5 ins. wide on top, 8¾ ins. inside on the bottom, and 3½ ins. deep inside. Half the ties (Type A) have a central diaphragm made of a piece of angle iron ⅜ × 5 × 3 ins., riveted inside the top of the tie and projecting below the tie. The other ties (Type B) have two diaphragms, near the ends, formed of angles ⅜ × 3 × 3½ ins., and these do not project below the body of the tie. These diaphragms are for the purpose of anchor-

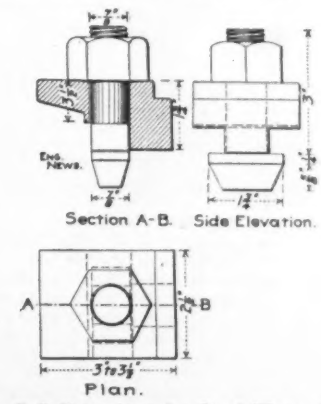


Fig. 2. Rail Fastenings for Steel Ties: Bessemer & Lake Erie Ry.

ing the ties in the ballast and so holding them in line. At each rail seat are two rectangular holes 17-32 × 2 ins., 8 7-16 ins. c. to c. In these holes are fitted bolted clamps or clips of a pattern which has been extensively used for metal ties in Germany. The body of the clamp enters the hole and its flange bears on the rail base. The clamps are made in five sizes, 3 to 3½ ins. wide, thus allowing for adjustment of gage on curves. The ⅞-in. bolt has a T-head which passes through the hole and is then turned so as to take a bearing inside the tie. The weight of the tie is about 205 lbs.

These ties were laid in May and June, 1901, on 2,135 ft. of track a little distance south of Osgood, Pa.; most of them being on a reverse curve of

4½° and 9°. The track was ballasted with furnace slag, and a portion of this track was given a final surfacing with limestone screenings by the pneumatic machine invented by the late Mr. E. J. Patterson, of Titusville, Pa. The screenings were blown under the tie by an air jet, so as to fill all voids and make a solid bed. Until the end of April, 1902, all the traffic went over this track, but since then the southbound ore trains and about half the northbound freight trains have been run over the cut-off between Osgood and Kremis. The passenger trains, local freight trains and about half the northbound through freight trains still run over this track. The 9° curve at the north end has not been surfaced or lined since the early part of June, 1901. It has been necessary to surface the south end on account of its being on a soft roadbed.

The ties were put in for experimental purposes, particularly as to comparative cost of maintenance of way, and is was recognized at the time that they had certain objections: (1) they contained too much metal; (2) it was difficult to line the track after it had been surfaced. As the life of the tie would probably be greater than that of the rail, the fastening was such as to allow of changing the section of rail without having to change the ties. Failure to provide for this led to the removal of the Chester steel ties on the Huntington & Broad Top Mountain Ry., as noted in the review of the railway tie situation in our issue of Sept. 10.

The experience on the Bessemer & Lake Erie Ry. indicates that a tie of trough shape can be tamped properly with a tamping pick, and that on account of the rigid and secure rail fastening, there is less wear of rails on the curves. Two different designs are now being prepared, as suggested by the experience with the present ties. It may be noted that the reduction in rail wear on curves, due to fastenings which hold the rails and tie rigidly together (which a spike fastening cannot do) has been observed also with steel ties and concrete ties on the Lake Shore & Michigan Southern Ry.

A REBELLION AT PANAMA against the Colombian government began on Nov. 3, the purpose of which is said to be the organization of Panama as an independent state with a view to granting to the United States the franchise for the construction of the Panama Canal.

THE 1,000-TON BARGE CANAL PROPOSITION was approved by the voters of the State of New York in the election on Nov. 3, the majority in favor being estimated at over 200,000 at the hour of going to press. The favorable vote on the proposition was due to the great majorities in its favor cast in the counties represented in Greater New York. The majority in favor of the proposition in these counties amounted to about 350,000. This added to the favorable majority of about 40,000, cast by the counties in the vicinity of Buffalo, was sufficient to greatly overbalance the majority of about 175,000 against the proposition, which was recorded in the remainder of the state. As all the New York City newspapers with one exception strongly favored the proposition and it was endorsed by both parties in the municipal election, the heavy vote in its favor in that city is not a matter for surprise. Under the law, as now approved, the State Engineer is to proceed to "improve" the Erie, Oswego and Champlain canals, "so that the canal prism shall, in regular canal sections, have a minimum bottom width of 75 ft., and a minimum depth of 12 ft., and a minimum water cross section of 1,128 sq. ft." The locks are to be single locks (with the exception of the flights of locks at Waterford and Lockport) and are to be 328 ft. long, 28 ft. wide and 11 ft. deep on the miter sills. While the new canals will follow the general route of the present canals, a slack water navigation will be established on the Mohawk, Oneida and Oswego rivers. The entire work is to be under the joint control of the State Engineer and the Superintendent of Public Works, in conjunction with the Canal Board, made up of various state officials; but the Governor is also authorized to employ an advisory board of "five expert civil engineers, whose duty it shall be to advise the State Engineer and the Superintendent of Public Works, as they may require." The engineers and inspectors on the work are to be appointed by the State Engineer.

AN ELECTRIC TOWING SYSTEM FOR CANAL BOATS was exhibited in operation at Schenectady, N. Y., on Oct. 28, in presence of a party, which included Gov. Odell and a number of other state officials. Besides the towpath of the canal for a distance of 2,700 ft., there had been erected a low elevated structure, consisting of two lines of plate girders, the outer one a little higher than the inner and both supported by a single line of posts set in concrete. On each of these girders ran an electric trolley, taking current from an overhead wire. Each trolley weighed 12,000 lbs., and its weight available for traction was increased to double this amount by means of wheels running on the bottom of the girder, a spring being used to produce a gripping effect. The motors were geared to the driving wheels to produce a slow speed. In the exhibition tests a string of four boats was towed at a speed of 4½ to 5 miles per hour. The system is the invention of Stephen W. Wood, of Newark, N. J., and is controlled by the International Towing & Power Co., of 10 Wall St., New York city. The structure was erected by the Jones & Laughlin Co., of Pittsburg, and the details of the electric trolley and the electrical equipment generally were worked out by the engineers of the General Electric Co.

A LAUNCHING FAILURE occurred on Oct. 31 at the yard of the New York Shipbuilding Co., Camden, N. J. The steamship "Manchuria," building for the Pacific Mail Steamship Co., stuck on the ways when released for launching, and could not be moved by all available jacks, so that the ceremony had to be postponed. The vessel is 625 ft. long, 65 ft. in extreme breadth, and 51 ft. deep in the hold. The total displacement is nearly 27,000 tons. The vessel has 15,000-HP. engines, to give a speed of 16 knots.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a butting collision, which occurred on the Cleveland, Cincinnati, Chicago & St. Louis Ry., in the outskirts of Indianapolis, Ind., on Oct. 31. An inbound passenger train crowded with students of Purdue University on their way to a football game collided with a freight train leaving a siding. The collision completely wrecked the first two cars of the passenger train. Sixteen persons were killed.——A number of other fatal railway accidents are recorded for the week past. Two of these were derailments, one that of a through passenger train on the Atchison, Topeka & Santa Fe Ry., near Dean Lake, Mo., which caused two deaths, and the other the derailment of a freight train at a switch on the Southern Ry. near Bessemer City, N. C., in which four were killed.

DEPRECIATION OF WATER MAINS due to electrolysis at Richmond, Va., is estimated at an average of 22.2% or $170,224 on a first cost of $766,974, by Mr. Dabney H. Maury, M. Am. Soc. C. E., of Peoria, Ill. This estimate is included in a report to the city authorities of Richmond, dated Aug. 21, 1903, and just made public. It is based on "the relation which the depth of the deepest pits" found on 101 different lines of pipe, exposed by trenching at 50 street openings, "bears to the actual thickness of the pipes" at those openings, and makes no allowance for pits on the interior of the pipe. Moreover, the first cost of the distribution system was much lower per unit of length than that of pipe relaid in present day repairs, since the repairs and replacements are now made piecemeal, in paved instead of unpaved streets, and with far more numerous interruptions by traffic than occurred when the mains were originally laid. Service pipes were not examined by Mr. Maury, but according to a statement made to him by Mr. C. E. Bolling, Superintendent of Water-Works, there are 15,000 extra heavy lead services in Richmond, of which over 200 "have already actually burst from electrolysis." Besides the direct damage to the mains and services electrolysis has caused many incidental losses, such as loss of water and injury thereby to pavements, car tracks, building foundations and flooded goods, besides the continued risks to life and property through threatened failure of the water supply for fire protection. Voltmeter readings at some 60 places showed unusually low differences of potential compared with other cities, and these were, as a rule, less than those found by another observer several years ago. The street railway companies "have of late been very diligent in improving the rail bonds and return feeders," but Mr. Maury things that little further reduction of electrolysis can be expected from such work, and since the present conditions are serious and the injury already done great and still increasing in amount, he strongly recommends that the city council "adopt such reasonable measures as may result in securing the change from the single to the double trolley system in the shortest possible time."

THE PENNSYLVANIA R. R. HAS STOPPED part of its improvement work and has reduced its operating department forces, an announcement of which is made by President Cassatt, thus:

> We have stopped part of the construction work, but it is a comparatively small part, and not a general reduction. It includes the heavy work on the low grade improvements between Columbia and Parkersburg, and between Thorndale and Paoli, on the Philadelphia division. This work could not, in any event, have been completed in less than a year or 18 months, and the expectation is that we shall go on with it in the spring. This is the only work of importance which is stopped. All the rest of construction work on the line is going actively on. We have also, as stated in the papers, made considerable reductions of force in the operating department. During the congested period of last fall and winter, considerations of economy had to be put to one side; it was necessary to move the traffic at any cost, and as a consequence the number of men in the service was largely increased. By the reductions now being made we are simply returning to normal conditions. Our lines are now working freely, and we anticipate no trouble in moving the traffic during the coming winter.

MECHANICAL FILTRATION EXPERIMENTS, including a long period of coagulation and sedimentation, have been followed by the adoption of that method of treating water drawn from the Nile, through the Mahmoudieh Canal for the supply of Alexandria, Egypt. This conclusion is all the more interesting since the Alexandria Water Co. had previously adopted plans for treatment with permanganate of potash, a long period of subsidence, and slow sand filtration. A 26,000-gallon mechanical filter unit, with three 4,000-gallon settling tanks, was installed in October, 1902, by the Jewell Export Filter Co., and operated about 8 weeks. Bacillus prodigious, in large quantities, were applied to the filters and practically all removed. The ordinary water bacteria averaged 2,000 in the applied water, 400 to 600 after 6 to 9 hours coagulation and sedimentation, and, for "about 11-12 of the duration of the run" they were reduced by the filter to 40 or less per cu. cm. A higher number of bacteria in the filtered water was found, as usual, after washing the filter. The foregoing statements are based on an advance copy of a report of the tests, written by Dr. H. Bitter, Director of the Egyptian State Institute of Hygiene at Cairo, who represented the Egyptian Government. The Alexandria Water Co. was represented by its Chief Engineer, Mr. H. R. C. Blagden. The experimental plant was especially designed by Mr. Edmund B. Weston, M. Am. Soc. C. E., of Providence, R. I. Dr. Ritter advised, as a result of the tests, that 22 to 25 grammes per cu. m. of sulphate of alumina should be used (or an average of about 1¾ grains per gallon), assuming 21% of soluble alumina, that at least six hours be allowed for subsidence; that the rate of filtration be regulated to 100 cu. m. per sq. m. per 24 hours (115,000,000 gallons a day), with an increase to 120 cu. m in case of emergency; and that the effluent be run to waste for 30 minutes after washing the filters. Accompanying Dr. Bitter's report is an interesting historical sketch of the Alexandria Water Co., by Mr. Blagden, who states that the company will install a plant as follows: Three masonry coagulating and settling basins, each having a capacity of 105,600 gallons, and 18 Jewell filters, with a combined daily capacity of 9,600,000 gallons. The filter tanks will be of steel, 17 ft. inside diameter. This gives a total area of 4,086 sq. ft., and a rate of filtration of some 2,300 cu. ft. per sq. ft., or about 100,000,000 gallons per acre per day.

ASSISTANT CIVIL ENGINEERS in the Navy will be appointed, three in January, and one in March, 1904, according to the following governing rules:

> No person shall be appointed who is less than 23, or more than 28 years of age.
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> Candidates for appointment shall be examined as to their physical fitness by a board of medical officers of the navy and as to their mental and professional qualifications by a board of such officers as the Secretary of the Navy may designate for the purpose.
>
> The physical examination shall precede the mental and professional, and if a candidate is found physically unfit for appointment he shall not be further examined.
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> Application for permits to be examined must be made to the Secretary of the Navy, and must be accompanied by testimonials as to character, evidence of American citizenship, evidence of having received a degree in the civil engineering course of some professional institution of good repute, a record of at least two years' practical experience as a civil engineer, and a physician's certificate as to health and physical soundness. No person shall be admitted who has been examined at any time within six months prior to the date of this examination and failed to meet the professional requirements.
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> The mental and professional examination will be competitive and in writing and will comprise such subjects as the following: Testimonials and adaptability; English grammar and composition; elementary physics; elementary geology; drawing; arithmetic; algebra; geometry; trigonometry; analytical geometry; differential and integral calculus; applied mathematics, including mechanics of solids and fluids and strains in structures; electricity; construction materials; engineering constructions, such as workshops, steam and electrical machinery; quay walls, wharves, sewers, yard railways, pavements, water distribution, foundations, etc.; surveying (topographical, trigonometrical and hydrographical) and mapping; instruments, their use and adjustment.
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> Candidates who pass satisfactorily will be arranged by the board in the order of their relative merit as determined by such examination, but no candidate will be considered as having passed a satisfactory examination who does not attain a general average of 80%.
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> The examination will be held beginning Nov. 23, 1903, at the navy yard, New York, N. Y., and candidates to whom permits may be issued should present themselves before the medical officer or board at that place at 10 o'clock a. m. on that date. The professional examination will occupy about ten days.

A SUIT INVOLVING CAR TRUCK PATENTS has recently been decided against the North Jersey Street Railway Co. The suit was brought by John A. Brill for an injunction to prevent the use of trucks built by the Peckham Motor Truck & Wheel Co. The patents involved were Nos. 627,898, and 627,900, June 27, 1899, covering the system of spring-suspended and semi-elliptic spring equalizers. The case was tried before Judge Bradford, Judge for the District of Delaware, and he awarded a perpetual injunction.